MCR-80-637

NONMETALLIC MATERIALS

CONTAMINATION STUDIES

FINAL TECHNICAL REPORT

CONTRACT 955426 JPL

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FOREWORD

This report describes the results of work conducted under Contract 955426 JPL by the Martin Marietta Corporation, Denver Aerospace, Denver, Colorado. This work was administered by the Jet Propulsion Laboratory, Pasadena, California and the Contract Officer for JPL was Tim O'Donnell.

This report covers the period of 2 April 1979 to 14 November 1980. Program Manager for Martin Marietta was Ernest Ress. Principal contributors to the program were Dr. J. Muscari and G. Beverlin.

ABSTRACT

This final technical report presents the results of the non-metallic materials contamination study. In order to impose adequate, but not restrictive contamination control requirements in the selection of Wide Field Planetary Camera (WFPC) materials and to develop a data base of potential optical degradation of the WFPC charge-couple device window; the outgassing properties of WFPC materials and the collected volatile condensed material (CVCM) effects on MgF_2 transmittance were measured. Changes in the transmittance were monitored in the wavelength region from 115 nm to 300 nm for selected CVCM thicknesses up to 150 nm. The outgassing properties of reemitted CVCM was also studied.

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1.0 SUMMARY

This final technical report presents the results of the nonmetallic materials contamination study. In order to impose adequate, but not restrictive contamination control requirements in the selection of Wide Field Planetary Camera (WFPC) materials and to develop a data base of potential optical degradation of the WFPC charge-couple device window; the outgassing properties of WFPC materials, the collected volatile condensed material (CVCM) effects on MgF_2 transmittance, and the outgassing properties of the reemitted CVCM were measured.

The sample weight loss of furnished WFPC materials has been measured with a thermogravimetric analyzer. Making the assumption that the weight loss follows first order rate theory, the source kinetic parameters of these materials is presented. The source material temperature was increased from ambient to about 300°C and, in addition to the weight loss data, a residual gas scan (12 to 750 amu) was taken every 25°C. The data shows a significant portion of the volatile condensed material (VCM) is composed of light molecules, 12 to 46 amu, that in general will not condense at temperatures above -160°C in vacuum. The vacuum bake at 176°F significantly reduced the amount of active material in all cases except Scotchweld and EA-9309. For the Brand X tape, the vacuum bake removed the first component of the active material to within the sensitivity of the thermogravimetric analyzer. For Chemglaze Z-306, the 9922 primer has a lower amount of active material than AP-131 primer. For Cat-A-Lac 463-3-8, the addition of the primer 463-6-5 does not significantly increase the amount of active material. The RGA data shows that the vacuum bake significantly reduces the percent of heavy molecules (above 46 amu) emitted for EA-934, 3M-415, Brand X, and 3M Nextel unprimed.

An isothermal mass loss test using MLI at 32°C found a linear mass loss rate of 5×10^{-5} %$\cdot$min^{-1} after the initial period. The RGA data during this test showed a negliable amount of heavy molecules emitted and that nitrogen molecules make up about 50% of the light molecules emitted during the isothermal phase.

The transmittance of varying thicknesses of CVCM from 28 furnished source disks was measured from 115 nm to 300 nm. The source disk was maintained at a temperature around 50°C and both a MgF_2 window (deposition substrate for the CVCM) and a temperature controlled quartz crystal microbalance (TQCM) were controlled near -80°C. Significantly low values of transmittance were found for wavelengths below 230 nm even for thin films of CVCM. For example, assuming that the density of Ablebond 36-2 CVCM is

1.0 g·cm^{-3}, for a thickness of CVCM of 48 Å, a transmittance of only 0.64 at Lyman Alpha (122 nm) was recorded. At a thickness of only 151 Å, the CVCM from Trabond BB-2116 was opaque for wavelengths shorter than 160 nm. Strong absorption near 200 nm was found for many CVCMs.

The CVCM reemission parameters for ten materials was determined by increasing the temperature of the TQCM crystal (substrate for the CVCM) to 101°C. The TQCM frequency, rate of frequency change, and the temperature were used to obtain first order reemission parameters. The deposited contaminants have rate constants different from the parent material. In general, all of the CVCM is reemitted at a temperature near 100°C. Also, for most cases, allowing the contaminated window to reach ambient temperature produced the initial clean window values of transmittance.

2.0 INTRODUCTION

2.1 Background - The major advantage of the Space Telescope program is that a low earth orbit telescope makes it possible to observe fainter astronomical sources at higher resolution and in wavelength regions not possible through the earth's atmosphere. A space vehicle, however, can generate an induced environment or atmosphere from outgassing of non-metallic materials and various operational activities such as vents and attitude control system firings which in themselves may contaminate and degrade the performance of the telescope. It is, therefore, a basic programmatic requirement that contamination be minimized both on the Space Telescope and on each scientific instrument to be flown in the Space Telescope.

Contamination source kinetics is far from the stage of simply stating a few general laws to explain the entire process. However, there are common aspects in all non-metallic materials outgassing that lend to general classification and semi-quantitative interpretation. The spacecraft materials screening test[1] measuring the Total Mass Loss (TML) and Volatile Condensable Material (VCM) has become a standard method (ASTM E595) to quantitatively measure the outgassing of materials and their condensables in a vacuum environment. While this is an appropriate screening procedure to categorize materials, it does not provide enough source rate kinetic parameters to assess detail contamination problems of sensitive instruments. Nor does it provide the necessary information on the reemission of the VCM from the critical surface.

Current Martin Marietta Corporation, Denver Aerospace contamination modeling theory[2] has postulated applying kinetic rate theory to predict source outgassing characteristics. Once the source parameters are known; source rates can be combined with mass transport equations, deposition rates and finally reemission rates to assess the degree of deposition that will degrade spacecraft surfaces. Both dynamic thermogravimetry (DTG) and isothermal thermogravimetry (ITG) are used in this process to obtain the source outgassing rates and the reemission rates. Once the source kinetics are understood, then the degradation of these deposits can be established for sensitive instrument surfaces.

[1] R.F. Miraca and J.S. Whittick, Stanford Research Institute, N67-40270, September 1967.

[2] Satellite Contamination Final Technical Report, AFML-TR-78-15, Vol. 1, July 1978.

In general, instruments detecting in the far ultraviolet regions are the most susceptible to contaminant effects on the reflectance or transmittance of optical train elements. Films as thin as a 0.6 monolayer have decreased reflectance of a mirror by 60 percent at 122 nm in the laboratory[3] and almost complete blockage of the vacuum ultraviolet filters of a Skylab spectrograph in space.[4] Although the Wide Field Planetary Camera (WFPC) beam-bending mirror exposed continously outside the main instrument housing is of concern, the cold MgF_2 windows (about -100°C, which would have very low reemission of any CVCM deposited on it) covering the charge-coupled device (CCD) is very susceptilbe to contaminant deposition.

2.2 Purpose - In order to impose adequate, but not restrictive contamination control requirements in the selection of WFPC materials and to develop a data base of potential optical degradation of the CCD window, the outgassing properties of WFPC materials and the CVCM effects on MgF_2 transmittance will be measured. As a result of this study, the source kinetics, reemission and vacuum ultraviolet (VUV) effects data will be obtained for a wide range of space materials as applied to the WFPC.

[3]R.C. Richmond, Space Simulation Symposium, NASA SP-298, May 1972.

[4]J.A. Muscari, B.J. Jambor and P.A. Westcott, Evaluation De L'Action De L'Environnement Spatial Sur Les Materiaux, June 1974.

3.0 TECHNICAL DISCUSSION

3.1 Facility Preparation - Figure 1 shows a schematic of the test facility. A windowless glow discharge lamp uses hydrogen gas to produce a continuum from about 160 to 300 nm. The band structure of the excited hydrogen gas provides a pseudo continuum for the interval 115 to 160 nm. An auxillary pumping system consisting of a turbomolecular pump is used to reduce the gas load on the VacIon monochromator pump. The one meter normal incidence vacuum ultraviolet monochromator has an oscillating grazing incidence mirror that produces two beams. The sample beam is focused by a MgF_2 lens into the vacuum optical degradation (VOD) test chamber which has its own VacIon pumping system. The VOD test chamber houses the source heater, cryogenic MgF_2 window plate holder, the temperature controlled quartz crystal microbalance (TQCM) and the sample beam detector. The source heater is a copper plate which can be heated by four Minco sealed resistive heaters or cooled by LN_2. A thermocouple is pressed against the outgassing material to record the source temperature. A thermocouple is also pressed against the MgF_2 window and thermally isolated from the copper plate holder. This thermocouple not only records the temperature of the witness window but is used to regulate the flow of the cooling LN_2 and maintain the window and TQCM at the selected temperature. The TQCM has its own platinum thermistor to monitor and display the temperature of the crystals. Another MgF_2 lens is placed in the reference beam to balance the efficiency of the two beams. A ratio recording system accepts the signals from the sample and reference lock-in voltmeters. The TQCM is used to determine the CVCM mass flux at the witness window and thus is kept at the same temperature as the MgF_2 window.

Initial tests were performed without the outgassing source to determine the VOD background conditions. The TQCM which has a sensitivity of 1.56×10^{-9} $g \cdot cm^{-2} \cdot Hz^{-1}$ was heated from -100°C to +100°C to determine the change in frequency due to crystal temperature. No corrections to the frequency output is necessary below -50°C and above +10°C. About 2 Hz·°C must be subtracted from the frequency to correct for this temperature effect when the CVCM reemission tests are being performed. The TQCM also shows a frequency shift of about 30 Hz when exposed to the thermal load from a heated source holder plate at +50°C and 2.54 cm separation distance. The temperature of the source could be controlled to within ±2°C over a five day period and the window could be held to within ±5°C. The TQCM was controlled to within ±2°C. The pressure in the VOD chamber even during the source outgassing tests remained in the low 10^{-6} Torr region. The VOD chamber and

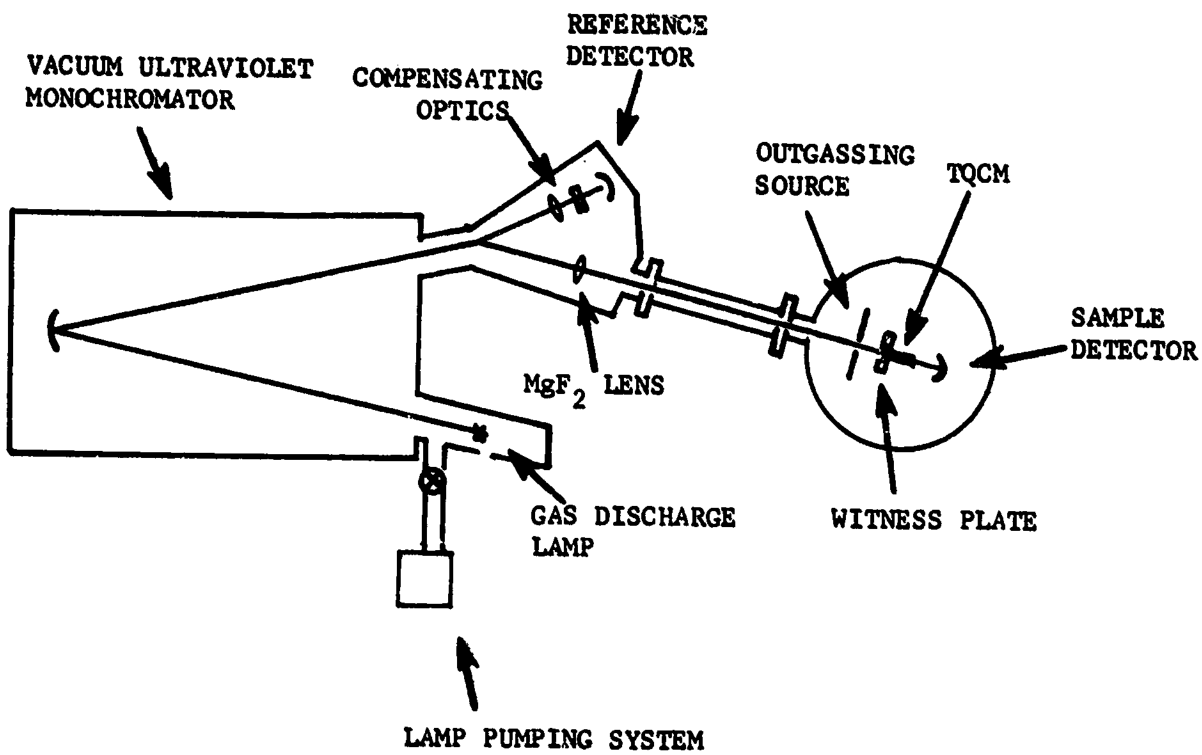

Figure 1. Schematic of the Test Setup and Facilities

and source heating subsystem cleanliness level was demonstrated by heating the source holder to 60°C and holding the TQCM at 20°C. After several hours only about 7 Hz of CVCM was deposited onto the TQCM. The test was repeated with the TQCM at 10°C and only a 3 Hz increase in frequency was measured. Figure 2 shows the TQCM frequency output with the source holder at 60°C and the TQCM at -87°C. Thus, for this 7.5 hour period 66 Hz or 1.03×10^{-7} $g \cdot cm^{-2}$ was deposited. The linear deposition rate indicates a zero order outgassing source which fits the behavior of water molecules.

Normalization curves for background transmittance and deposition were developed by repeating the full test procedure without an outgassing source material installed onto the heater. Figures 3 and 4 present the background data used to normalize all the VOD test data.

3.2 Dynamic Thermogravimetric Tests and Results

3.2.1 Theory - The time and temperature dependence of the mass loss rate of non-metallic sources is the first step required for contamination assessment. The mass loss determination is a complex process involving many components in a given material. Assessment of TML/VCM at one temperature does not give sufficient data to extrapolate the characteristics of a material to other temperatures and times. Classical rate theory can be applied when the source outgassing is expected to be a surface phenomena. The basic relationship,[5] per component, in a material can be expressed as:

$$\dot{m}_s(t,T) = k_s(T)(a_o - x)^n \tag{1}$$

where $\dot{m}_s$ = source mass loss rate per unit area, $g \cdot cm^{-2} \cdot min^{-1}$,

k_s = source rate constant, $(g \cdot cm^{-2})^{1-n} \cdot min^{-1}$,

a_o = initial mass available for outgassing, $g \cdot cm^{-2}$,

x = mass loss, $g \cdot cm^{-2}$,

n = order of reaction,

t = time, and

T = source temperature.

[5] E.S. Freeman and B. Carroll, J. Phys. Chem., 62, 394, 1958.

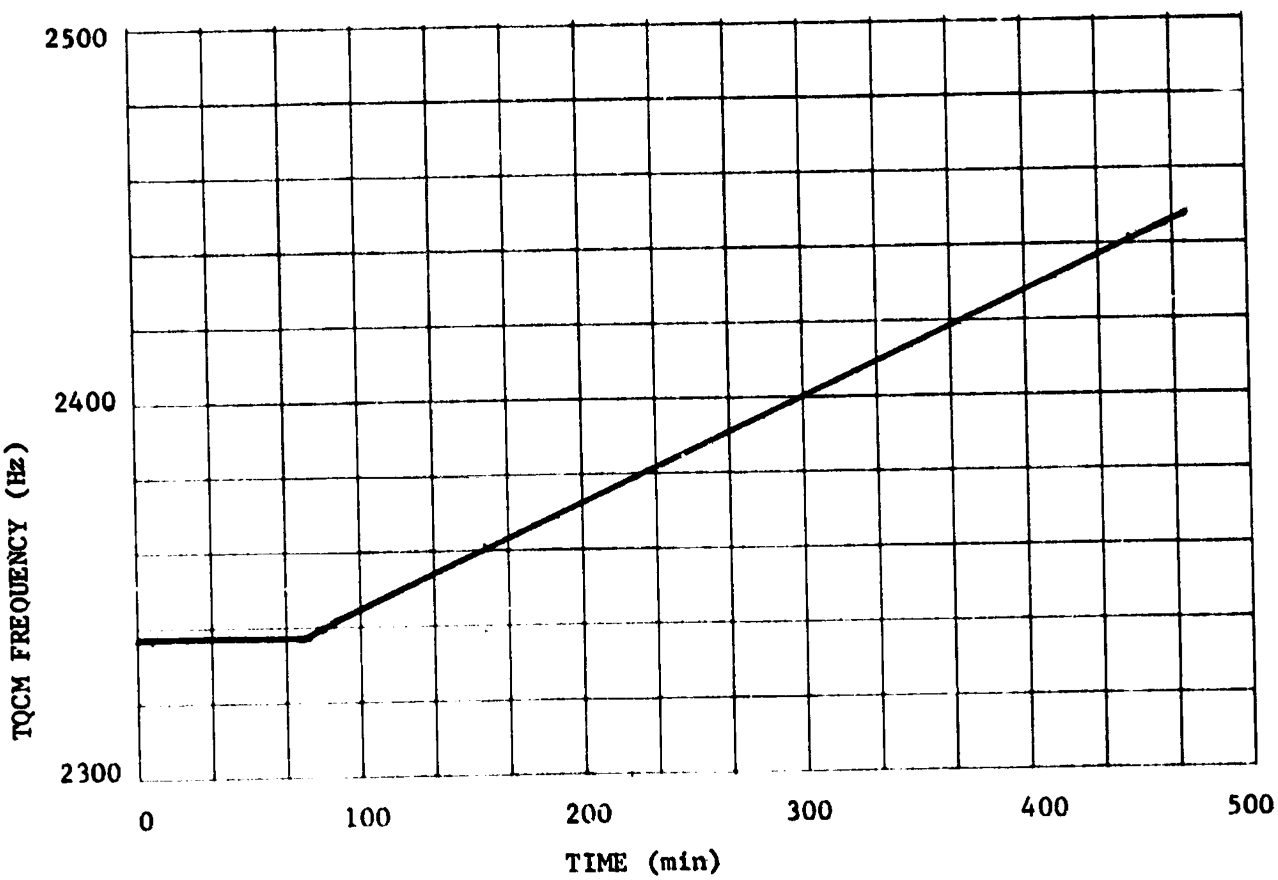

Figure 2. Deposition On TQCM At -37°C Versus Time While Source Holder Plate At +60°C.

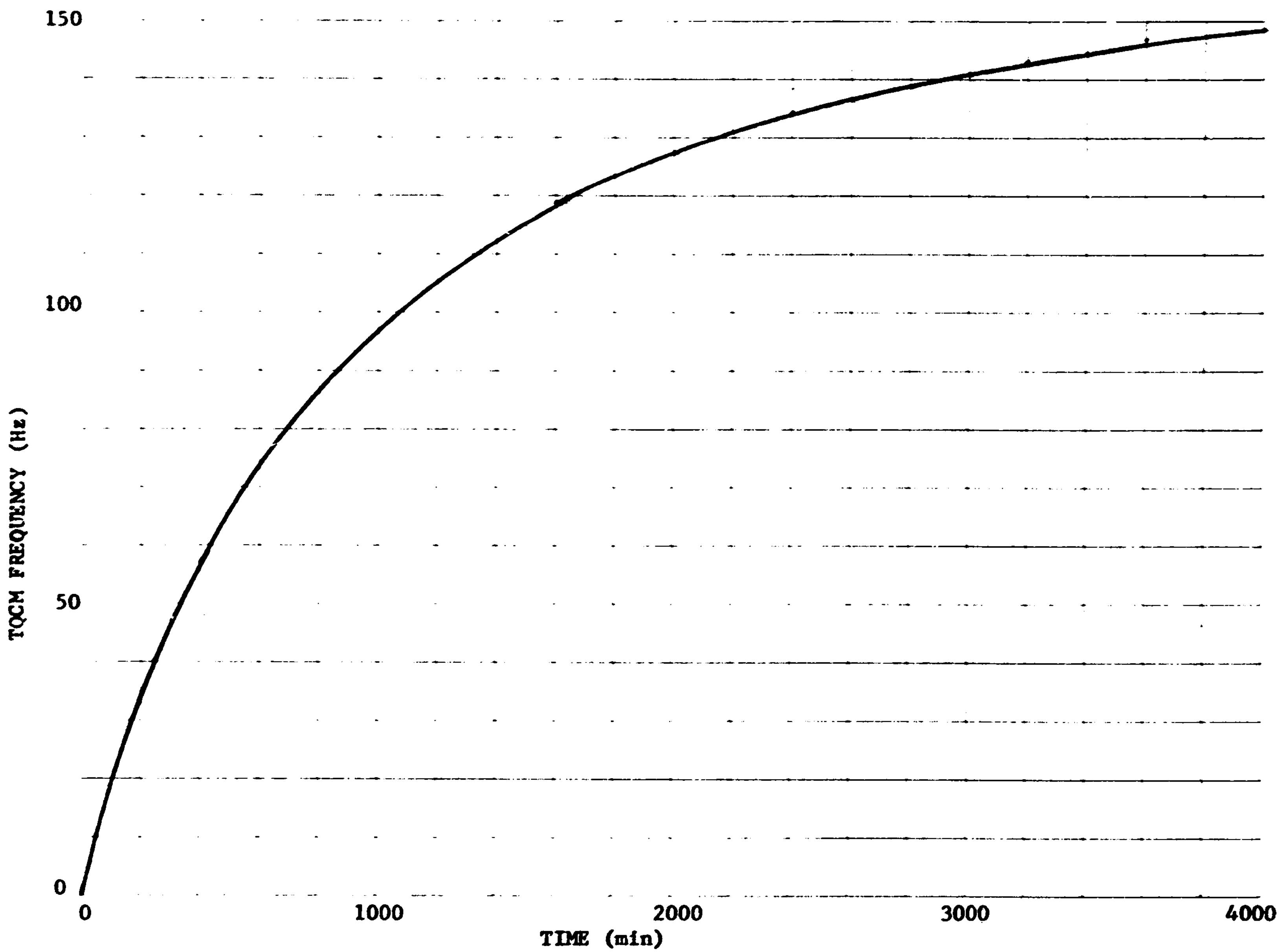

Figure 3. Chamber Background CVCM Frequency Versus Time.

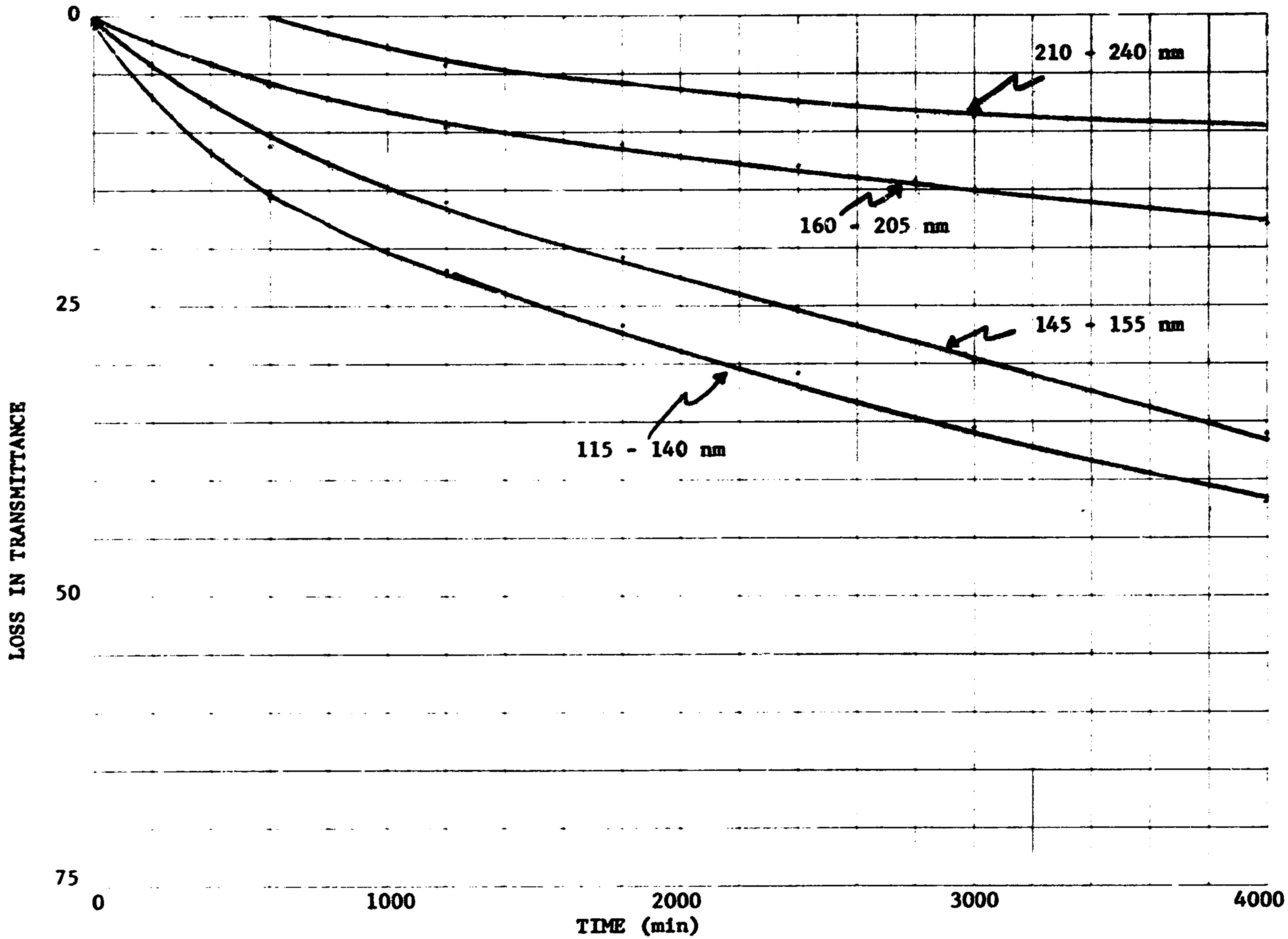

Figure 4. VOD Chamber Background Loss In Transmittance Versus Time. No Correction For Wavelengths Greater Than 240 nm.

Equation (1) assumes no diffusion barriers exist for the outgassing components. For unique materials, it may be desirable to determine the order of the reaction, n, experimentally. However, for most of the cases observed for non-metallics, the order of reaction is very near unity. If it is assumed that the rate constant, k, can be expressed in an Arrhenius form, then it can be determined from plotting ln k versus T^{-1} and is expressed as:

$$k_s = A\ e^{-E/(RT)} \qquad (2)$$

where A = frequency factor (independent of temperature), min^{-1},

E = effective energy, $cal \cdot mole^{-1}$,

R = molar gas constant, namely, 1.986 $cal \cdot mole^{-1} K^{-1}$, and

T = absolute temperature, K.

DTG obtains the values for $\dot{m}_s$, a_o, x and, if necessary, n. Thus, using equations (1) and (2), the mass loss rate expression can be generalized for any temperature and time, namely;

$$\dot{m}_s = k a_o e^{-kt}, \text{ and} \qquad (3)$$

$$m_s = a_o(1 - e^{-kt}). \qquad (4)$$

3.2.2 DTG Tests - DTG is a continuous process that involves the measurement of sample weight as the temperature is increased by means of a programmed rate of heating. The output from a typical thermogravimetic analyzer consists of weight loss (TGA), expanded TGA (ten times), derivative of TGA (DTG), temperature, test chamber pressure and residual gas analysis (RGA). The derivative thermogravimetry transforms electronically the weight data into a rate of weight change. In our Mettler I system, the temperature rate can be set from $0.2^{\circ}C \cdot min^{-1}$ to $25^{\circ}C \cdot min^{-1}$, at $\pm 4^{\circ}C$. The DTG data can be read to 0.01 $mg \cdot min^{-1}$. Weight losses from 0 to 1 g can be measured. In the zero to 10 mg range, the precision is $\pm$0.015 mg, the accuracy is $\pm$0.03 mg, and the readability is 0.005 mg. Temperatures from 25°C to about 300°C were obtained; regulated to $\pm 1.5^{\circ}C$ and readable to 1.25°C. An RGA scan was taken approximately every 25°C for the full temperature range. It operates in the mass range from 12 to 750 AMU with a sensitivity of 100 $A \cdot Torr^{-1}$ for N_2.

Table I lists the GFP WFPC materials that have been tested with the thermogravimetric analyzer. The multilayer insulation (MLI) was tested both dynamically (temperature increased from ambient to +300°C) and isothermally. After the MLI tests, the GFP materials were coded by JPL. Thus, the early tests are designated by the material name and curing process.

In general, the TG source materials were applied to clean metallic foil to the expected flight thickness. The metallic foils were cleaned using appropriate solvents and vacuum baked at 300°C for six hours before applying the outgassing material. The prepared source was then cured by one or more of the planned treatments. The weights of the foil and material were also measured. The foil was used to provide a barrier similar to the instrument structure for one surface or to a paint primer. Thus, any primer can only contribute to the source mass loss from its edges or by diffusion through the outer paint coating. A piece of the GY-70/Fiberite 934, Fiberite 934, MLI, Braycote, and Epon 815/Versamid 140 were used without any substrate.

Table II presents the TG derived source parameters for each of the materials and for each material component found up to 300°C. The 3M-415, JPL#141-TGA-2, test did not produce any usable data (except for the residual gas analysis). However, it was possible to determine the amount of volatile material, a_{01} plus a_{02}, namely, 1.51×10^{-2}. Thus, the curing process of 24 Hr at 176°C in vacuum reduced the available outgassing material by about 27%. The Fiberite 934 tests showed no measurable mass loss for temperatures below 200°C, test sample weight up to 177 mg. The weight loss between 200°C and the maximum temperature 300°C was due to a very large outgassing rate occurring above 300°C. In general, active outgassing components whose rate peaks above 300°C do not significantly contribute any mass loss at nominal spacecraft temperatures around 50°C. The Fiberite 934 52A-TGA-1 and 52B-TGA-1 tests showed outgassing so large that the beam balance registered mass gain. This "buoyancy effort" is well known for materials with large outgassing rates. the inial sample weight of 140 mg was also toolarge to keep the data on scale. Sample 52B-TGA-1 showed no weight loss for temperatures below 160°C, at that temperature the system went buoyant. The residual gas measurements show a very large outgassing for the Fiberite 934 material. The Braycote 3L-38-RP material showed a very rapid weight loss beginning at 200°C and continuing beyond 300°C reaching no peak. The weight loss rate was about $3.6\% \cdot min^{-1}$. The unprimed 3M Nextel 401-C10 test, 143-TGA-1, for an initial weight of 67 mg went buoyant for temperatures greater than 60°C. It was possible to estimate the

Table I Thermogravimetric Tested Materials.

MATERIAL	DESCRIPTION	PROPOSED APPLICATION
Ablebond 36-2	Ag filled epoxy adhesive	Bonding CCD chips to Au/Ni coated Invar (Substrate)
TRA-BOND BB-2116	2-part epoxy (Bipax kit)	Bonding CCD chips to substrate
Epon 828/Versamid 140	Epoxy laminating resin	Resin matrix in glass/epoxy CCD support bands
Epon 828/Epon 871/AEP A) 7 Day Ambient Cured B) Oven Cured	Epoxy resin with felexibilized epoxy	Spot bonding various components
Scotchweld 2216 B/A A) Ambient Cured B) 2 Hr @ 150°F	Grey or clear flexibiilized epoxy	General purpose bonding
Chemglaze Z-306 with primer 9922 A/B	Flat black, one-part polyurethane base, flexible paint with 2-part epoxy primer coat	Used on surfaces requiring high thermal emittance and/or diffuse reflective behavior
Chemglaze Z-306		
Chemglaze Z-306/Chemlock Primer		
Cat-a-lac No. 463-3-8	Flat black, carbon pigmented 2-part epoxy base paint	Used on surfaces requiring high thermal emittances and/or diffuse reflective behavior
Cat-a-lac No. 463-3-8 with primer No. 463-6-5	Flat black epoxy over epoxy primer	Used on surfaces requiring high thermal emittances and/or diffuse reflective behavior
GY-70/Fiberite 934 Veil FEP, 4 Ply Boeing T-300/934	Graphite/epoxy cured laminate of high modulus graphite fiber (Celanese GY-70) and 2-part epoxy resin cured between 275 and 350°F)	Optical Bench Structure (OBS)
Hysol EA-9309 A) Ambient Cured B) 1 Hr @ 180°F	Epoxy, semirigid, opaque grey, thixotropic, high temperature cure	Structural bonds in Optical Bench Structure
Hysol EA-934 A/B A) Ambient Cured B) 1 Hr @ 180°F	Epoxy, semirigid, opaque grey, room temperature cure	Same as above

Table 1 (continued)

MATERIAL	DESCRIPTION	PROPOSED APPLICATION
Reinforced Film - Apex Mills Net/Mylar Film	Multilayer Insulation	Thermal Control Surfaces
3M-415 A) 141-TGA-1 B) 141-TGA-2	Double Coated Taped Mylar Base, Pressure Sensitive	Flat Pack Mounting And IC Stick Modules
Brand X A) 142-TGA-1 B) 142-TGA-2	Double Coated Tape	Flat Pack Mounting And IC Stick Modules
Fiberite 934 A) 52-TGA-1 B))52A-TGA-1 C) 52B-TGA-1	Hot Melt Resin	Optical Beneh Structure
Braycote 3L-38-RP 112-1	Grease Lubricant	Mechanism
Cat-A-Lac 463-3-8/ 463-6-5 115B-TGA-2	Flat Black Epoxy Over Epoxy Primer	High Thermal Emittance Surfaces
Cat-A-Lac 463-3-8 127-TGA-2	Flat Black Epoxy	High Thermal Emittance Surfaces
Chemglaze Z-306/AP-131 129-TGA-2	Flat Black Epoxy AP-131 Primer	High Thermal Emittance Surfaces
Epon 815/Versamid 140 A) 139-2 B) 139-3	Epoxy Laminating Resin	Resin Matrix In Glass/ Epoxy CCD Support Bonds
3M Nextel 401-C10 A) 143-TGA-1 B) 143-TGA-2	Flat Black Paint	
3M Nextel 401-C10/ 901-P1 A) 144-TGA-1 B) 144-TGA-2	Flat Black Paint Over Primer	
Solithane 113/C113- 300 Formulation # 8 12A-TGA-1	Semiflexible Transparent Polyurethane Resin	Conformal Encapsulation of Electrical Conductors
Solithane 113/C113- 300 Formulation # 1 12B-TGA-1	Semiflexible Transparent Polyurethane Resin	Conformal Encapsulation of Electrical Conductors

Table II Thermogravimetric Derived Parameters For Mass Loss.

MATERIAL	EFFECTIVE ACTIVATION ENEGRY (cal $mole^{-1}$)		FREQUENCY CONSTANT (min^{-1})		NORMALIZED ACTIVE MATERIAL	
	E_1	E_2	A_1	A_2	a_{01}	a_{02}
ABLEBOND 36-0[illegible]	16200	17400	$4.95x10^{8}$	$3.13x10^{7}$	$2.73x10^{-3}$	$1.69x10^{-3}$
TRABOND BB-2116	7960	--	$1.13x10^{4}$	--	$1.41x10^{-2}$	--
EPON 829/VERSAMID 140	10400	--	$3.68x10^{5}$	--	$2.13x10^{-3}$	--
EPON 828/EPON 871/AEP						
AMBIENT CURED	9940	--	$3.96x10^{4}$	--	$1.52x10^{-2}$	--
OVEN CURED	14200	--	$4.63x10^{6}$	--	$1.24x10^{-2}$	--
SCOTCHWELD 2216 AMBIENT CURED	15000	--	$5.31x10^{5}$	--	$8.80x10^{-3}$	--
SCOTCHWELD 2216 CURED 2 Hr @ 150°F	11300	--	$6.21x10^{4}$	--	$9.30x10^{-3}$	--
CHEMGLAZE Z-306	17200	--	$2.7x10^{8}$	--	$9.03x10^{-3}$	--
CHEMGLAZE Z-306 9922 PRIMER	18800	42000	$1.52x10^{9}$	$2.15x10^{16}$	$1.18x10^{-2}$	0.233
CHEMGLAZE Z-306 AP-131 PRIMER	30800	24200	$2.33x10^{12}$	$4.31x10^{8}$	0.317	0.339
CAT-A-LAC #463-3-8	10600	--	$2.06x10^{5}$	--	$6.90x10^{-2}$	--
CAT-A-LAC #463-3-8 463-6-5 PRIMER	13000	--	$3.10x10^{6}$	--	$6.95x10^{-2}$	--

Table II (continued)

MATERIAL	EFFECTIVE ACTIVATION ENERGY (cal mole^{-1})		FREQUENCY CONSTANT (min^{-1})		NORMALIZED ACTIVE MATERIAL	
	E_1	E_2	A_1	A_2	a_{01}	a_{02}
GY-70/FIBERITE 934	11600	--	2.21×10^{5}	--	3.21×10^{-3}	--
HYSOL EA-9309 AMBIENT CURED	34100	--	4.96×10^{16}	--	1.01×10^{-3}	--
HYSOL EA-9309 CURED 2 Hr @ 150°F	10200	--	1.69×10^{4}	--	3.09×10^{-3}	--
HYSOL E-934 A/B AMBIENT CURED	10300	--	3.21×10^{4}	--	4.53×10^{-3}	--
HYSOL EA-934 A/B CURED 1 Hr @ 180°F	6220	--	2.96×10^{2}	--	2.35×10^{-3}	--
MLI	14900	37300	2.36×10^{7}	3.12×10^{15}	9.84×10^{-4}	2.38×10^{-3}
3M FILM TAPE #415 JPL# 141-TGA-1	25800	42200	4.81×10^{15}	8.91×10^{18}	1.34×10^{-3}	1.93×10^{-2}
3M FILM TAPE #415 JPL# 141-TGA-2 CURED 24 Hr @ 176°F/Vacuum	TEST DATA NOT USABLE				1.51×10^{-2}	
BRAND X TAPE JPL# 142-TGA-1	23700	26000	3.25×10^{14}	6.36×10^{10}	1.88×10^{-3}	2.09×10^{-2}
BRAND X TAPE JPL# 142-TGA-2 CURED 24 Hr @ 176°/Vacuum		31100		5.47×10^{14}		1.63×10^{-3}

Table II (continued)

MATERIAL	EFFECTIVE ACTIVATION ENERGY (cal mole^{-1})		FREQUENCY CONSTANT (min^{-1})		NORMALIZED ACTIVE MATERIAL	
	E_1	E_2	A_1	A_2	a_{01}	a_{02}
Fiberite 934 JPL# 52-TGA-1 CURED 24 Hr @ 275°F/Vacuum	NO WEIGHT LOSS T < 200°C; NO PEAK T < 300°C					
Fiberite 934 JPL# 52-TGA-2 CURED 24 Hr @ 275°F/Vacuum NO ALUMINUM SUBSTRATE	NO WEIGHT LOSS T < 200°C; NO PEAK T < 300°C					
FIBERITE 934 JPL# 52A-TGA-1 CURED 24 Hr @ 275°F/Vacuum	TEST DATA NOT USABLE OUTGASSING EXCEEDED RANGE OF INSTRUMENT					
FIBERITE 934 JPL# 52B-TGA-1	TEST DATA NOT USABLE OUTGASSING EXCEEDED RANGE OF INSTRUMENT					
BRAYCOTE 3L-38-RP JPL# 112-1	TEST DATA NOT USABLE OUTGASSING EXCEEDED RANGE OF INSTURMENT					
CAT-A-LAC 463-3-8/463-6-5 JPL# 115B-TGA-2 CURED 24 Hr @ 176°F/Vacuum	12400	--	4.3×10^4	--	5.05×10^{-2}	--

Table II (continued)

MATERIAL	EFFECTIVE ACTIVATION ENERGY (cal mole^{-1})		FREQUENCY (min^{-1})		NORMALIZED ACTIVE MATERIAL	
	E_1	E_2	A_1	A_2	a_{01}	a_{02}
CHEMGLAZE Z-306/AP-131 JPL# 129C-TGA-2 CURED 24 Hr @ 176°F/Vacuum	15100	--	1.02×10^{9}	--	2.98×10^{-3}	--
EPON 815/VERSAMED 140 JPL# 139-2	31200	--	3.90×10^{11}	--	3.66×10^{-3}	--
EPON 815/VERSAMED 140 JPL# 139-3 CURED 24 Hr @ 176°F/Vacuum	37400	--	2.16×10^{15}	--	1.17×10^{-3}	--
3M NEXTEL 401-C10 JPL# 143-TGA-1	OUTGASSING EXCEEDED RANGE				0.121	--
3M NEXTEL 401-C10 JPL# 143-TGA-2 CURED 1 Hr @ 150°F/Atm. 24 Hr @ 176°F/Vacuum	OUTGASSING EXCEEDED RANGE					
3M NEXTEL 401-C10/ 901-P1 JPL# 144-TGA-1	20300	--	1.37×10^{10}	--	0.134	--
3M NEXTEL 401-C10/ 901-P1 JPL# 144-TGA_2 CURED 1 Hr @ 150°F/Atm 24 Hr @ 176°F/Vacuum	8230	--	2.72×10^{4}	--	3.57×10^{-2}	--

Table II (continued)

MATERIAL	EFFECTIVE ACTIVATION ENERGY (cal $mole^{-1}$)		FREQUENCY (min^{-1})		NORMALIZED ACTIVE MATERIAL	
	E_1	E_2	A_1	A_2	a_{01}	a_{02}
Solithane 113/C113-300 JPL# 12A-TGA-1 Formulation #8	12600	--	$1.26x10^{6}$	--	$4.01x10^{-3}$	--
Solithane 113/C113-300 JPL# 12B-TGA-1 Formulation #1	22100	--	$6.40x10^{10}$	--	$3.94x10^{-3}$	--
CAT-A-LAC 463-3-8 JPL# 127-TGA-2 CURED 24 Hr @ 176°F/Vacuum	12400	--	$1.52x10^{5}$	--	$4.46x10^{-2}$	--

amount of normalized active material for the first component, namely, $a_{01} = 0.12$ or 0.021 cm^{-2}. The cured 3M Nextel, 143-TGA-2, likewise went off scale and no usable data was obtained for the 70 mg test sample.

Tables III to XL present the RGA data for each of the materials at selected temperatures, data was taken every 25°C. The second and third columns list the total number of counts (relative intensity) registered from 12 to 46 amu (light molecules) and from 47 amu upwards. The fourth column for water sums the number of counts registered at 18 amu plus the factor 0.23 times the counts at 17 amu. The last column shows the highest mass measured at that temperature within the sensitivity of the RGA. The percentages listed under the counts is simply that fraction of the registered counts within that region to the total registered at that temperature, neglecting the variation in RGA sensitivity with respect to mass number and any molecular fractioning. The RGA data does indicate that water is a significant portion of the VCM from all of the materials even up to temperatures of 300°C. It is likely that few of the light molecules (12-46 amu) will condense at surface temperatures above -100°C.

A piece of MLI, 187.48 mg and 80.86 cm^2, was placed in the TG crucible and heated to 32°C and kept there for 1500 min. Figure 5 presents the isothermal mass loss (after time 60 min) in percent for MLI. The linear region shows a mass loss rate of 5×10^{-5} $\% \cdot min^{-1}$. In trying to reach the planned isothermal temperature of 32°C, the TG system over shot to 43°C in the first 10 min. before stabilizing at the desired temperature. The behavior of the MLI after 250 min is typical of a two component material. The first component is highly volatile and produces the observed exponential mass loss during the early time of isothermal outgassing. The second component is a low volatile species that exhibits a linear mass loss at low temperatures for exposure times of less than a few years. Table XLI presents the RGA data for this isothermal test. The relative counts show that nitrogen molecules make up about 50% of the light molecules emitted during the isothermal phase.

TABLE III Residual Gas Analysis Digital Amplifier Output In Counts For Ablebond 36-2.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	359,255 (98.8%)	4,462 (1.2%)	226,490 (62.3%)	85
100	910,624 (98.3%)	15,633 (1.7%)	640,110 (69.1%)	86
125	931,017 (98.5%)	14,549 (1.5%)	604,753 (64.0%)	99
150	622,203 (97.5%)	15,962 (2.5%)	365,590 (57.3%)	99
175	596,639 (95.1%)	30,991 (4.9%)	279,737 (44.6%)	99
200	674,462 (93.8%)	44,663 (6.2%)	269,856 (37.5%)	100
225	706,937 (94.2%)	43,485 (5.8%)	349,796 (46.6%)	215
250	773,408 (93.3%)	55,462 (6.7%)	268,664 (32.4%)	229

TABLE IV Residual Gas Analysis Digital Amplifier Output In Counts For Tra-Bond BB-2116.

Temperature Material (^{o}C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	310,991 (99.8%)	663 (0.2%)	194,500 (62.4%)	85
100	1,748,569 (99.5%)	8,360 (0.5%)	974,701 (55.5%)	95
150	2,392,726 (99.6%)	8,726 (0.4%)	1,814,966 (75.6%)	107
200	1,280,550 (99.1%)	11,640 (0.9%)	924,088 (71.5%)	107

TABLE V Residual Gas Analysis Digital Amplifier Output In Counts For Epon 828/Versamid 140.

Temperature Material (^{o}C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	193,011 (99.8%)	341 (0.2%)	110,591 (57.2%)	66
100	317,565 (97.6%)	7,930 (2.4%)	198,015 (60.8%)	66
150	565,399 (99.8%)	1,415 (0.2%)	382,432 (67.5%)	78
200	579,614 (99.6%)	2,386 (0.4%)	403,106 (69.3%)	78

TABLE VI Residual Gas Analysis Digital Amplifier Output In Counts For Epon 828/Epon 871/AEP Air Cured.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	124,731 (99.9%)	101 (0.1%)	76.609 (61.4%)	55
100	680,223 (98.8%)	8,049 (1.2%)	430,454 (62.5%)	86
150	1,785,824 (98.5%)	27,832 (1.5%	1,048,949 (57.8%)	93
200	1,079,213 (95.8%)	47,060 (4.2%)	613,360 (54.4%)	95
250	1,128,691 (90.7%)	115,208 (9.3%)	394,014 (31.7%)	95
300	3,510,119 (84.9%)	621,875 (15.1%)	1,156,462 (28.0%)	236

TABLE VII Residual Gas Analysis Digital Amplifier Output In Counts For Epon 828/Epon 871/AEP Oven Cured.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	281,934 (98.7%)	3,628 (1.3%)	167,832 (58.8%)	78
100	687,924 (97.4%)	18,053 (2.6%)	459,864 (65.1%)	92
150	1,342,946 (98.0%)	27,697 (2.0%)	933,184 (68.1%)	92
200	1,001,568 (96.7%)	33,785 (3.3%)	608,624 (58.8%)	93
250	1,158,299 (92.9%)	88,471 (7.1%)	485,776 (39.0%)	95

TABLE VIII Residual Gas Analysis Digital Amplifier Output In Counts For Scotchweld 2216 Ambient Cured.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	521,698 (99.5%)	2,689 (0.5%)	345,145 (65.8%)	76
150	1,423,688 (97.4%)	38,630 (2.6%)	996,469 (68.1%)	95
200	1,641,974 (96.8%)	54,114 (3.2%)	1,148,605 (67.7%)	96
250	1,773,517 (95.4%)	85,674 (4.6%)	1,207,531 (64.9%)	99
300	1,291,034 (91.4%)	120,963 (8.6%)	765,899 (54.2%)	233

TABLE IX Residual Gas Analysis Digital Amplifier Output In Counts For Scotchweld 2216 Cured Two Hours At 150°F.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	258,200 (99.6%)	934 (0.4%)	151,387 (58.4%)	71
150	1,570,383 (96.8%)	52,082 (3.2%)	1,094,799 (67.5%)	131
200	1,879,662 (94.7%)	104,561 (5.3%)	1,336,960 (67.4%)	132
250	1,166,961 (89.0%)	143,591 (11.0%)	718,339 (54.8%)	132

Table X Residual Gas Analysis Digital Amplifier Output In Counts For Chemglaze Z-306 With 9922 Primer.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecules (counts)	Maximum Mass (AMU)
25	142,144 (100%)	0 (0%)	91,905 (64.7%)	44
100	214,098 (94.5%)	12,511 (5.5%)	84,034 (37.1%)	92
150	207,592 (98.3%)	3,667 (1.7%)	87,181 (41.3%)	78
200	239,318 (97.0%)	7,401 (3.0%)	99,733 (40.4%)	92
250	385,566 (92.9%)	29,367 (7.1%)	128,053 (30.9%)	107
300	439,664 (90.0%)	49,057 (10.0%)	113,470 (23.2%)	94

TABLE XI Residual Gas Analysis Digital Amplifier Output In Counts For Chemglaze Z-306.

Temperature Material (^{o}C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	109,671	0	65,586 (59.8%)	45
100	151,285 (96.2%)	6,002 (3.8%)	69,520 (44.2%)	88
150	186,374 (93.9%)	12,195 (6.1%)	67,248 (33.9%)	92
200	185,370 (90.5%)	19,502 (9.5%)	62,739 (30.6%)	94
250	316,627 (83.8%)	61,062 (16.2%)	69,933 (18.5%)	107
300	581,022 (85.4%)	99,526 (14.6%)	86,631 (12.7%)	102

TABLE XII Residual Gas Analysis Digital Amplifier Output In Counts For Chemglaze Z-306 With Chemlock Primer.

Temperature Material (^{o}C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	280,544 (98.9%)	3,244 (1.1%)	169,423 (59.7%)	88
200	343,246 (90.0%)	38,017 (10.0%)	125,000 (32.8%)	107
250	402,768 (87.4%)	57,885 (12.6%)	130,522 (28.3%)	107
300	722,813 (88.5%)	94,018 (11.5%)	135,816 (16.6%)	107
350	1,808,416 (84.1%)	342,717 (15.9%)	137,933 (6.4%)	107

TABLE XIII Residual Gas Analysis Digital Amplifier Output In Counts For CAT-A-LAC 463-3-8.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	226,805 (99.9%)	259 (0.1%)	144,876 (63.8%)	57
100	2,718,135 (79.7%)	691,416 (20.3%)	181,062 (5.3%)	113
150	2,135,331 (82.6%)	449,953 (17.4%)	152,824 (5.9%)	113
200	1,026,980 (84.3%)	191,245 (15.7%)	134,639 (11.1%)	112

TABLE XIV Residual Gas Analysis Digital Amplifier Output In Counts For CAT-A-LAC 463-3-8 With Primer 463-6-5.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	214,415 (99.7%)	587 (0.3%)	134,784 (62.7%)	72
100	2,430,810 (78.9%)	649,830 (21.1%)	231,428 (7.5%)	113
150	2,854,880 (81.9%)	629,477 (18.1%)	151,821 (4.4%)	113
200	1,504,186 (82.2%)	325,394 (17.8%)	130,211 (7.1%)	113
250	858,771 (87.6%)	121,156 (12.4%)	134,843 (13.8%)	112
300	560,444 (91.9%)	49,558 (8.1%)	158,987 (26.1%)	112

TABLE XV Residual Gas Analysis Digital Amplifier Output In Counts For GY-70/Fiberite 934.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	210,519 (99.7%)	672 (0.3%)	137,273 (65.0%)	81
100	730,107 (99.4%)	4,303 (0.6%)	549,126 (74.8%)	92
150	1,277,540 (99.5%)	6,126 (0.5%)	984,325 (76.7%)	175
200	1,188,684 (99.4%)	7,442 (0.6%)	901,051 (75.3%)	218
250	1,272,729 (97.6%)	30,774 (2.4%)	859,829 (66.0%)	236

TABLE XVI Residual Gas Analysis Digital Amplifier Output In Counts For Hysol EA-9309 Ambient Cured.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	283,802 (99.90%)	291 (0.10%)	160,445 (56.5%)	85
100	327,114 (99.04%)	3,157 (0.96%)	184,353 (55.8%)	86
150	736,646 (99.32%)	5,061 (0.68%)	367,996 (49.6%)	95
200	800,343 (98.53%)	11,981 (1.47%)	581,228 (71.6%)	95
250	1,060,123 (97.46%)	27,679 (2.54%)	789,811 (72.6%)	105
300	1,326,976 (95.45%)	63,246 (4.55%)	866,745 (62.3%)	108

TABLE XVII Residual Gas Analysis Digital Amplifier Output In Counts For Hysol EA-9309 Cured One Hour at 180°F.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	195,698 (99.94%)	124 (.063%)	115,355 (58.9%)	57
100	568,840 (98.40%)	9,235 (1.60%)	372,605 (64.5%)	95
150	1,358,473 (96.48%)	49,510 (3.52%)	1,068,304 (75.9%)	95
200	2,266,964 (96.64%)	78,813 (3.36%)	1,395,023 (59.5%)	108
250	2,552,262 (95.25%)	127,280 (4.75%)	1,438,627 (53.7%)	108
300	2,870,454 (92.34%)	238,013 (7.66%)	1,339,561 (43.1%)	108

TABLE XVIII Residual Gas Analysis Digital Amplifier Output In Counts For Hysol EA-934 A/B Ambient Cured.

Temperature Material (°C)	Sum of 12-46 AMU (counts	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	555,818 (97.0%)	17,322 (3.0%)	329,428 (57.5%)	95
50	530,935 (96.1%)	21,704 (3.9%)	294,574 (53.3%)	95
100	1,208,044 (96.7%)	41,759 (3.3%)	660,842 (52.9%)	96
150	2,060,525 (97.6%)	51,026 (2.4%)	1,445,545 (68.5%)	95
200	1,995,562 (96.9%)	64,404 (3.1%)	1,403,860 (68.1%)	95
250	2,127,058 (95.8%)	92,353 (4.2%)	1,450,531 (65.4%)	220

TABLE XIX Residual Gas Analysis Digital Amplifier Output In Counts For Hysol EA-934 A/B Cured One Hour at 180°F.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	441,285 (99.6%)	1,599 (0.4%)	287,138 (64.8%)	72
50	403,802 (99.4%)	2,483 (0.6%)	259,162 (63.8%)	72
100	787,565 (97.8%)	17,470 (2.2%)	547,369 (68.0%)	93
150	1,754,481 (98.4%)	28,229 (1.6%)	1,277,302 (71.6%)	94
200	2,144,258 (97.7%)	50,399 (2.3%)	1,537,741 (70.1%)	98
250	2,971,706 (96.8%)	97,066 (3.2%)	1,987,213 (64.8%)	98

Table XX Residual Gas Analysis Digital Amplifier Output In Counts For MLI.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	134,458 (100%)	0	83,201 (61.9%)	44
100	143,875 (99.9%)	213 (0.1%)	89,596 (62.2%)	57
150	169,142 (99.4%)	1,015 (0.6%)	107,430 (63.1%)	106
200	132,580 (99.6%)	566 (0.4%)	80,067 (60.1%)	57
250	132,906 (99.6%)	584 (0.4%)	71,819 (53.9%)	57
300	151,155 (99.5%)	771 (0.5%)	69,637 (45.8%)	57

Table XXI Residual Gas Analysis Digital Amplifier Output In Counts For 3M-415, JPL# 141-TGA-1.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	88,149 (100%)	0	23,146 (26.3%)	44
100	115,275 (99.2%)	954 (0.8%)	38,249 (32.9%)	70
200	601,997 (80.5%)	146,082 (19.5%)	128,491 (17.2%)	112
300	2,837,608 (60.5%)	1,849,410 (39.5%)	98,375 (2.1%)	113

Table XXII Residual Gas Analysis Digital Amplifier Output In Counts For 3M-415, JPL# 141-TGA-2.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	297,995 (100%)	0	117,721 (39.5%)	44
100	281,712 (100%)	0	115,505 (41.0%)	44
200	409,751 (99.0%)	4,008 (1.0%)	243,083 (58.7%)	71
300	640,511 (93.6%)	43,944 (6.4%)	421,894 (61.6%)	112

Table XXIII Residual Gas Analysis Digital Amplifier Output In Counts For Brand X, JPL# 142-TGA-1.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	61,982 (99.5%)	339 (0.5%)	31,981 (51.3%)	71
100	84,871 (94.2%)	5,234 (5.8%)	43,988 (48.8%)	111
200	553,684 (82.5%)	117,237 (17.5%)	137,403 (20.5%)	219
300	3,405,230 (61.2%)	2,159,266 (38.8%)	102,528 (1.8%)	232

Table XXIV Residual Gas Analysis Digital Amplifier Output In Counts For Brand X, JPL# 142-TGA-2.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	518,741 (100%)	0	333,290 (64.2%)	44
100	468,604 (100%)	0	292,936 (62.5%)	44
200	471,739 (99.2%)	3,645 (0.8%)	294,643 (62.0%)	71
300	1,148,274 (87.9%)	158,741 (12.1%)	423,376 (32.4%)	112

Table XXV Residual Gas Analysis Digital Amplifier Output In Counts For Fiberite 934, JPL# 52-TGA-1.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	564,660 (100%)	0	367,073 (65.0%)	44
100	491,443 (100%)	0	312,158 (63.5%)	44
200	748,713 (100%)	0	538,571 (71.9%)	44

Table XXVI Residual Gas Analysis Digital Amplifier Output In Counts For Fiberite 934, JPL# 52-TGA-2.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	300,412 (100%)	0	176,347 (58.7%)	44
100	274,509 (100%)	0	158,137 (57.6%)	44
200	356,994 (100%)	0	234,277 (65.6%)	44

Table XXVII Residual Gas Analysis Digital Amplifier Output In Counts For Fiberite 934, JPL# 52A-TGA-1.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	451,058 (100%)	0	264,491 (58.6%)	44
100	418,365 (100%)	0	247,117 (59.1%)	44
200	1,225,752 (100%)	90 (0.0%)	914,304 (74.6%)	47

Table XXVIII Residual Gas Analysis Digital Amplifier Output In Counts For Fiberite 934, JPL# 52B-TGA-1.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	1,337,915 (94.5%)	77,669 (5.5%)	569,491 (40.2%)	60
100	1,220,531 (94.5%)	70,941 (5.5%)	507,682 (39.3%)	60
300	5,673,189 (98.3%)	98,746 (1.7%)	4,325,265 (74.9%)	104

Table XXIX Residual Gas Analysis Digital Amplifier Output In Counts For Braycote 3L-38-RD, JPL# 112-1.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	404,512 (100%)	0	251,000 (62.1%)	44
100	347,550 (100%)	0	205,224 (59.0%)	44
200	422,758 (96.8%)	13,788 (3.2%)	178,936 (41.0%)	131
300	592,457 (69.4%)	261,517 (30.6%)	191,412 (22.4%)	135

Table XXX Residual Gas Analysis Digital Amplifier Output In Counts For Cat-A-Lac 463-3-8/463-6-5, JPL# 115B-TGA-2.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	514,334 (97.6%)	12,898 (2.4%)	313,999 (59.6%)	135
100	488,842 (97.1%)	14,724 (2.9%)	292,112 (58.0%)	135
200	4,692,645 (53.3%)	4,117,798 (46.7%)	337,844 (3.8%)	154

Table XXXI Residual Gas Analysis Digital Amplifier Output In Counts For Cat-A-Lac 463-3-8, JPL# 127-TGA-2.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	539,579 (99.8%)	1,042 (0.2%)	329,574 (61.0%)	119
100	560,795 (98.9%)	5,967 (1.1%)	336,352 (59.3%)	119
200	7,646,982 (65.6%)	4,004,534 (34.4%)	347,031 (3.0%)	154

Table XXXII Residual Gas Analysis Digital Amplifier Output In Counts For Chemglaze Z-306 AP-131, JPL# 129C-TGA-2.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	599,907 (100%)	0	376,206 (62.7%)	44
100	521,454 (100%)	0	318,629 (61.1%)	44
200	573,354 (93.8%)	38,361 (6.2%)	299,164 (48.5%)	174
350	2,355,294 (76.3%)	731,739 (23.7%)	267,042 (8.7%)	174

Table XXXIII Residual Gas Analysis Digital Amplifier Output In Counts For Epon 815/Versamid 140, JPL# 139-2.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	382,537 (100%)	0	222,607 (58.2%)	44
100	350,182 (100%)	0	205,629 (58.7%)	44
250	1,189,506 (98.6%)	17,373 (1.4%)	817,240 (67.8%)	106
350	2,504,761 (88.1%)	339,200 (11.9%)	1,064,640 (37.4%)	122

Table XXXIV Residual Gas Analysis Digital Amplifier Output In Counts For Epon 815/Versamid 140, JPL# 139-3.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	544,497 (100%)	0	325,955 (59.9%)	45
100	490,594 (100%)	0	290,266 (59.2%)	45
200	1,291,255 (99.1%)	12,146 (0.9%)	902,453 (69.2%)	106
300	4,178,505 (90.0%)	462,951 (10.0%)	1,968,636 (42.4%)	108

Table XXXV Residual Gas Analysis Digital Amplifier Output In Counts For 3M Nextel 401-C10, JPL# 143-TGA-1.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	595,676 (100%)	81 (0.0%)	378,211 (63.5%)	57
100	1,406,992 (99.9%)	1,743 (0.1%)	1,042,139 (74.0%)	87
200	1,598,429 (68.2%)	744,694 (31.8%)	610,573 (26.1%)	149
325	3,295,376 (72.6%)	1,242,866 (27.4%)	775,774 (17.1%)	205

Table XXXVI Residual Gas Analysis Digital Amplifier Output In Counts For 3M Nextel 401-C10, JPL# 143-TGA-2.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	529,341 (100%)	0	315,658 (59.6%)	44
100	1,442,610 (100%)	223 (0.0%)	1,049,365 (72.7%)	57
150	1,876,358 (93.8%)	123,325 (6.2%)	1,095,562 (54.8%)	107

Table XXXVII Residual Gas Analysis Digital Amplifier Output In Counts For 3M Nextel 401-C10/901-P1, JPL# 144-TGA-1.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	524,336 (100%)	0	311,804 (59.5%)	44
100	1,399,444 (100%)	387 (0.0%)	1,041,539 (74.4%)	59
225	1,490,160 (72.2%)	574,969 (27.8%)	493,299 (23.9%)	148
325	2,691,768 (67.0%)	1,325,623 (33.0%)	601,837 (15.0%)	203

Table XXXVIII Residual Gas Analysis Digital Amplifier Output In Counts For 3M Nextel 401-C10/901-P1, JPL# 144-TGA-2.

Temperature Material (°C)	Sum of 12-46 (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	467,525 (100%)	0	275,011 (58.8%)	44
100	1,540,678 (100%)	689 (0.0%)	1,072,174 (69.6%)	91
200	1,060,013 (70.7%)	440,329 (29.3%)	392,023 (26.1%)	148
300	2,537,329 (58.0%)	1,834,043 (42.0%)	488,341 (11.2%)	206

Table XXXIX Residual Gas Analysis Digital Amplifier Output In Counts For Solithane 113/C113-300, Formulation 8, JPL# 12A-TGA-1.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	434,579 (100%)	0	256,278 (59.0%)	44
100	402,208 (100%)	0	237,892 (59.1%)	44
250	2,619,245 (35.2%)	4,827,169 (64.8%)	159,579 (2.1%)	176

Table XL. Residual Gas Analysis Digital Amplifier Output In Counts For Solithane 113/C113-300, Formulation 1, JPL# 12B-TGA-1.

Temperature Material (°C)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
25	548,912 (100%)	0	334,169 (60.9%)	44
100	493,134 (100%)	0	294,821 (59.8%)	44
225	1,881,653 (65.1%)	1,008,076 (34.9)	205,952 (7.1%)	175

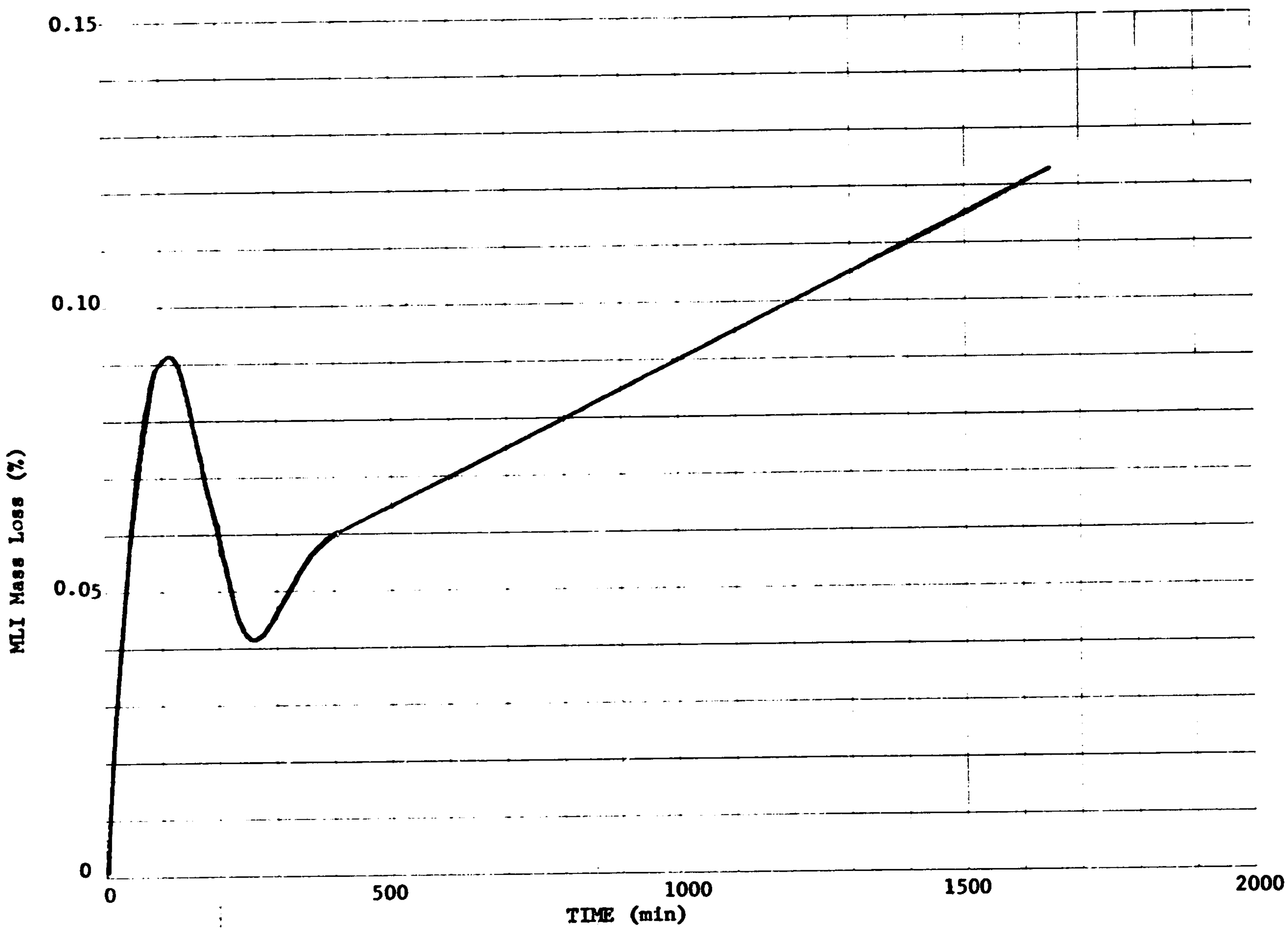

Figure 5. Isothermal Mass Loss In Percent For MLI At 32°C. Heat On At 25 min And MLI At 32°C At 60 min. Initial Weight Of MLI 187.48 mg And Sample Area 80.86 cm^2 (Note, Both Sides Of MLI Can Outgas Thus Outgassing Area Is 161.7 cm^2), Pressure 10^{-6} Torr.

Table XLI. Residual Gas Analysis Digital Amplifer Output In Counts For MLI Isothermal Test.

Temperature Material (°C)	Elapsed Time (min)	Sum of 12-46 AMU (counts)	Sum of 47-Maximum (counts)	Water Molecule (counts)	Maximum Mass (AMU)
8	0	977,031 (99.9%)	882 (0.1%)	689,269 (70.5%)	81
43	92	142,393 (100%)	64 (0.0%)	75,448 (53.0%)	57
32	207	69,704 (100%)	0	16,019 (23.0%)	44
32	1,647	50,192 (100%)	0	3,406 (6.8%)	44

3.3 Vacuum Optical Degradation Tests and Results

3.3.1 Test Facility and Procedures - The test facility shown previously in Fig. 1 was used to measure the transmittance of varying thicknesses of CVCM from GFP VOD sources. Each source consisted of two concentric segments. The central circular area was 2.54 cm in diameter and the outer concentric ring (coplanar with the central area) was 0.635 cm wide and 9.25 cm outer diameter. The source was designed to uniformly deposit CVCM on both the MgF_2 window and the TQCM crystal. The simple concentric ring configuration also allowed a closed form equation to be used in solving for the viewfactor between the source and receivers.[6] Figure 6 illustrates the source/receptor geometry.

Table XLII presents the planned VOD test matrix. However, the periods of transmittance measurements were tailored to the outgassing rate measured with each source material; thus, variations in the matrix did occur. Initial attempts to obtain the baseline (100%) transmittance of the clean MgF_2 window showed complete absorption of the vuv below 160 nm. It was assumed that water molecules in some form were being deposited on the -110°C window surface (chamber pressure remained in the low 10^{-6} Torr pressure region during all the tests). Raising the window temperature to -85°C extended the period of no significant degradation of transmission. The window and TQCM were controlled near -80°C and the outgassing source near +50°C. For some of the tests, the window was raised to -40°C and the transmittance measured in order to reemit any water molecules from the surface. The transmittance was also measured after each contaminated window reached ambient temperature.

3.3.2 VOD Test Results - The following figures and tables present the test results for each of the tested materials. Each column labeled T in the tables presents the transmittance of the CVCM for that specific thickness. The transmittance is calculated by dividing the ratio of the sample and reference lock-in voltmeters with the window contaminated to the ratio of the sample and reference voltmeters with the window clean. The columns labeled T# present the normalized CVCM transmittance obtained by adding the background transmittance (obtained from Fig. 4) to the measured transmittance, T. The figures showing

[6] D.C. Hamilton and W.R. Morgan, Radiant-Interchange Configuration Factors, NACA TN 2836, December 1952.

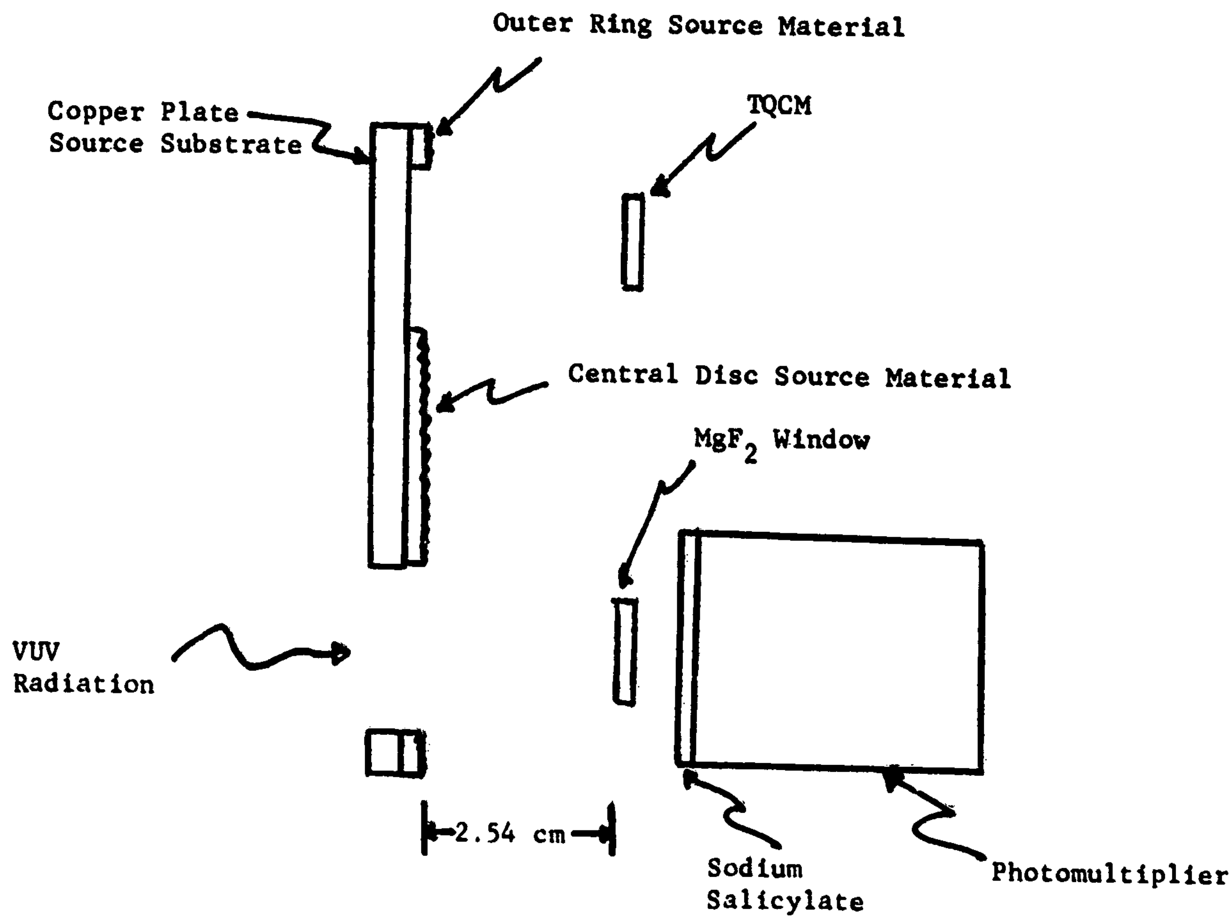

Figure 6. Schematic View Of VOD Source/Receptor Geometry.

Table XLII. VOT Test Matrix For Each Source Material

DAY OF WEEK	ACTION	OUTGASSING TIME AT T (Hrs)
Friday	Insert Source/Witness Plate	
Saturday	Vacuum Conditioning	
Sunday	Vacuum Conditioning	
Monday	Clean State Transmittance, T_0	
	Bring Source to Temperature, T	0
	Monitor Deposition, TQCM	
	Stop Deposition: Measure T_1	6
	Continue Deposition	
Tuesday	Monitor Deposition, TQCM	
	Stop Deposition: Measure T_2	24
	Continue Deposition	
Wednesday	Monitor Deposition, TQCM	
	Stop Deposition: Measure T_3	48
	Continue Deposition	
Thursday	Monitor Deposition, TQCM	
	Stop Deposition: Measure T_4	72
	Continue Deposition	
Friday	Monitor Deposition, TQCM	
	Stop Deposition: Measure T_5	100
	Bring Ambient Pressure, temp	
	Inspect Witness Plate	
	Insert New Source/Witness Plate	
	Clean Chamber	

the CVCM thickness in angstroms versus time have been corrected for periods of non-isothermal outgassing. Each plot begins when the source material reaches the stable isothermal temperature. After an appropriate time, the source heat was stopped and LN_2 flowed through the source holder tubing. The outgassing of the source stopped very quickly, monitored by the TQCM output. After the transmission measurement was performed, the source heat was turned on. It took about 20 minutes to bring the source up to its isothermal temperature. This period has been removed from the CVCM thickness plots. The CVCM estimated thickness is obtained by dividing the product of the TQCM sensitivity times the normalized TQCM frequency (measured value minus the chamber background obtained from Fig. 3 at the specific time) by an assumed CVCM density of 1.0 $g \cdot cm^{-3}$.

ABLEBOND 36-2

JPL#136-VOD-1

WEIGHT: 1.3342 g

CURE: 1 HR @ 257°F; AMBIENT PRESSURE

SOURCE TEMPERATURE: 51°C

WINDOW TEMPERATURE: -81°C

TQCM TEMPERATURE: -81°C

COMMENTS: TOTAL WEIGHT LOSS 0.5 mg
CVCM TRANSMITTANCE INVERSELY PROPORTIONAL TO WAVELENGTH
RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm
WARMED TO -60°C, NO AFFECT ON TRANSMITTANCE
AFTER TEST, AMBIENT TEMPERATURE, T = 0.87 @ 120 nm

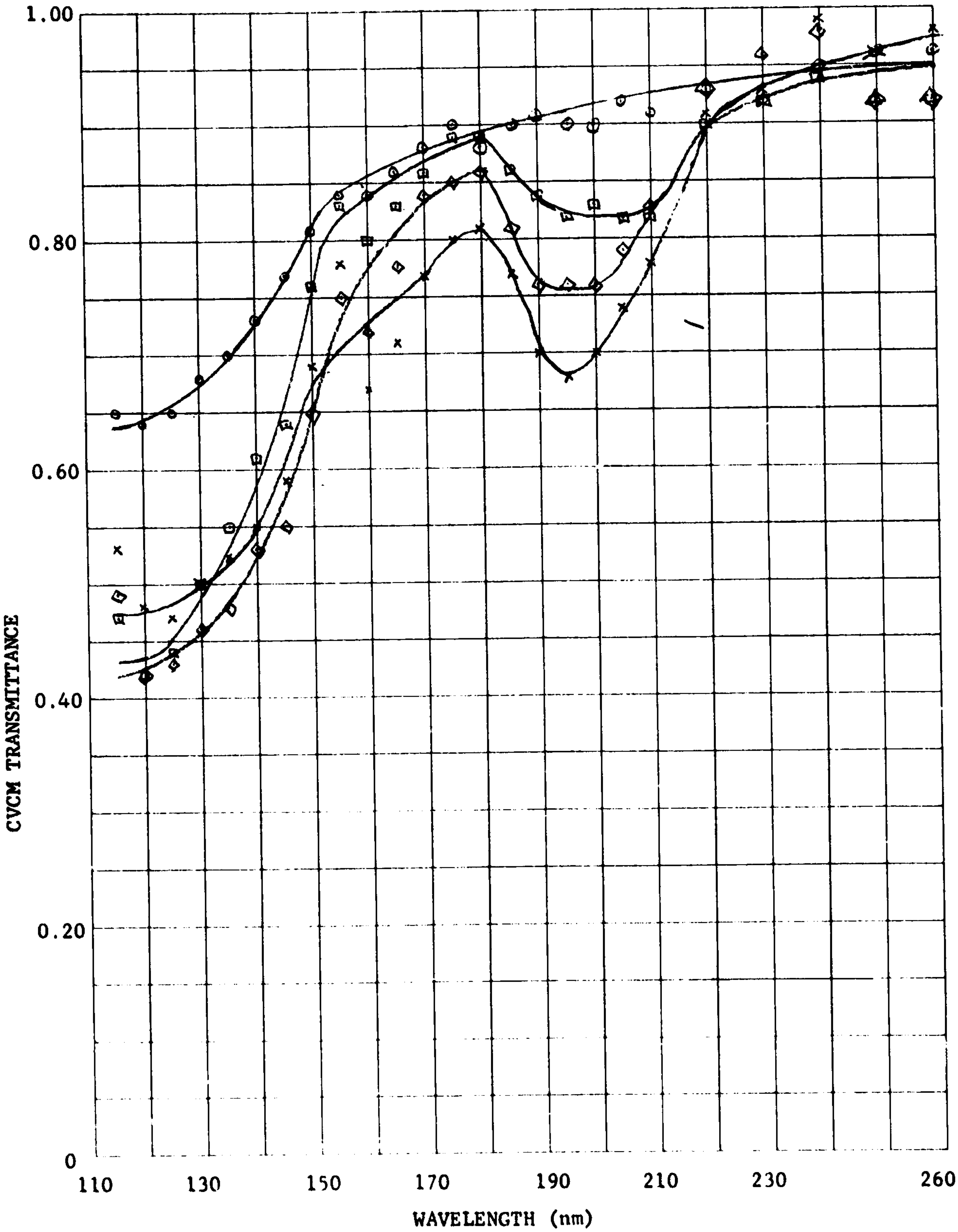

Figure 7. CVCM Transmittance Versus Wavelength, Source Material Ablebond 36-2 CVCM Thickness In Angstroms ○ 48, □ 76, ◇ 90, × 102.

Table XLIII. **CVCM Transmittance Versus Wavelength, Source Material Ablebond 36-2, Source Temperature 51°C, MgF_2 Window Temperature -81°C.**

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.60	0.65	0.26	0.47	0.17	0.49	0.11	0.53
120	0.59	0.64	0.21	0.42	0.10	0.42	0.06	0.48
125	0.60	0.65	0.23	0.44	0.11	0.43	0.05	0.47
130	0.63	0.68	0.29	0.50	0.14	0.46	0.08	0.50
135	0.65	0.70	0.34	0.55	0.16	0.48	0.10	0.52
140	0.68	0.73	0.40	0.61	0.21	0.53	0.13	0.55
145	0.74	0.77	0.48	0.64	0.29	0.55	0.20	0.59
150	0.78	0.81	0.60	0.76	0.39	0.65	0.30	0.69
155	0.81	0.84	0.67	0.83	0.49	0.75	0.39	0.78
160	0.82	0.84	0.71	0.80	0.58	0.72	0.49	0.67
165	0.84	0.86	0.74	0.83	0.64	0.78	0.53	0.71
170	0.86	0.88	0.77	0.86	0.70	0.84	0.59	0.77
175	0.88	0.90	0.80	0.89	0.71	0.85	0.62	0.80
180	0.87	0.88	0.80	0 89	0.72	0.86	0.63	0.81
185	0.89	0.90	0.77	0.86	0.67	0.81	0.59	0.77
190	0.90	0.91	0.75	0.84	0.62	0.76	0.52	0.70
195	0.88	0.90	0.73	0.82	0.62	0.76	0.50	0.68
200	0.88	0.90	0.74	0.83	0.63	0.76	0.52	0.70
205	0.91	0.92	0.73	0.82	0.65	0.79	0.56	0.74
210	0.91	0.91	0.78	0.82	0.75	0.83	0.68	0.78
220	0.93	0.93	0.86	0.90	0.85	0.93	0.81	0.91
230	0.92	0.92	0.88	0.92	0.88	0.96	0.83	0.93
240	0.95	0.95	0.90	0.94	0.90	0.98	0.89	0.99
250	0.96	0.96	0.92	0.92	0.92	0.92	0.96	0.96
260	0.96	0.96	0.92	0.92	0.92	0.92	0.98	0.98
270	0.96	0.96	0.92	0.92	0.93	0.93	0.97	0.97
280	0.95	0.95	0.93	0.93	0.94	0.94	0.95	0.95
290	0.95	0.95	0.94	0.94	0.95	0.95	0.95	0.95
300	0.97	0.97	0.97	0.97	0.94	0.94	0.97	0.97
CVCM THICKNESS (A)	48		76		90		102	
TIME AFTER 100% SCAN (min)	104		1095		2533		3693	

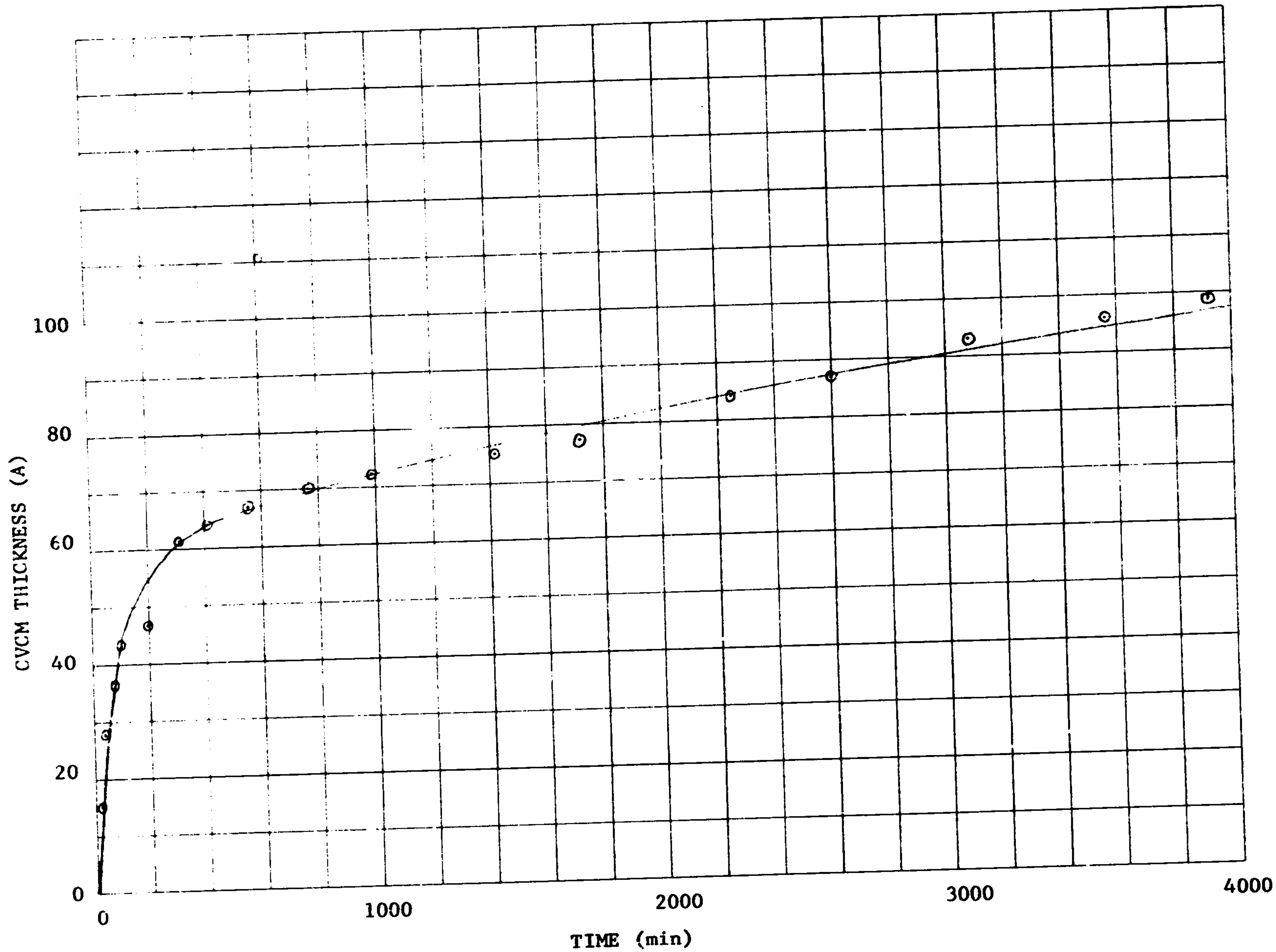

Figure 8. CVCM Thickness In Angstroms, Source Material Ablebond 36-2, Source Temperature 51°C, TQCM Temperature -81°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

TRABOND BB-2116

JPL#138-VOD-1

WEIGHT: 4.9240 g

CURE: 16 HR @ AMBIENT; AMBIENT PRESSURE

SOURCE TEMPERATURE: 49°C

WINDOW TEMPERATURE: -76°C

TQCM TEMPERATURE: -82°C

COMMENTS: STOPPED TEST AT 989 MIN; LN_2 VALVE STUCK OPEN, LN_2 RAN OUT ALLOWING WINDOW TEMPERATURE TO REACH +9°C

CVCM HIGHLY ABSORBING FOR WAVELENGTHS BELOW 160 nm

WARMED TO -40°C, NO AFFECT ON TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 0.45 @ 120 nm
T = 0.85 @ 300 nm

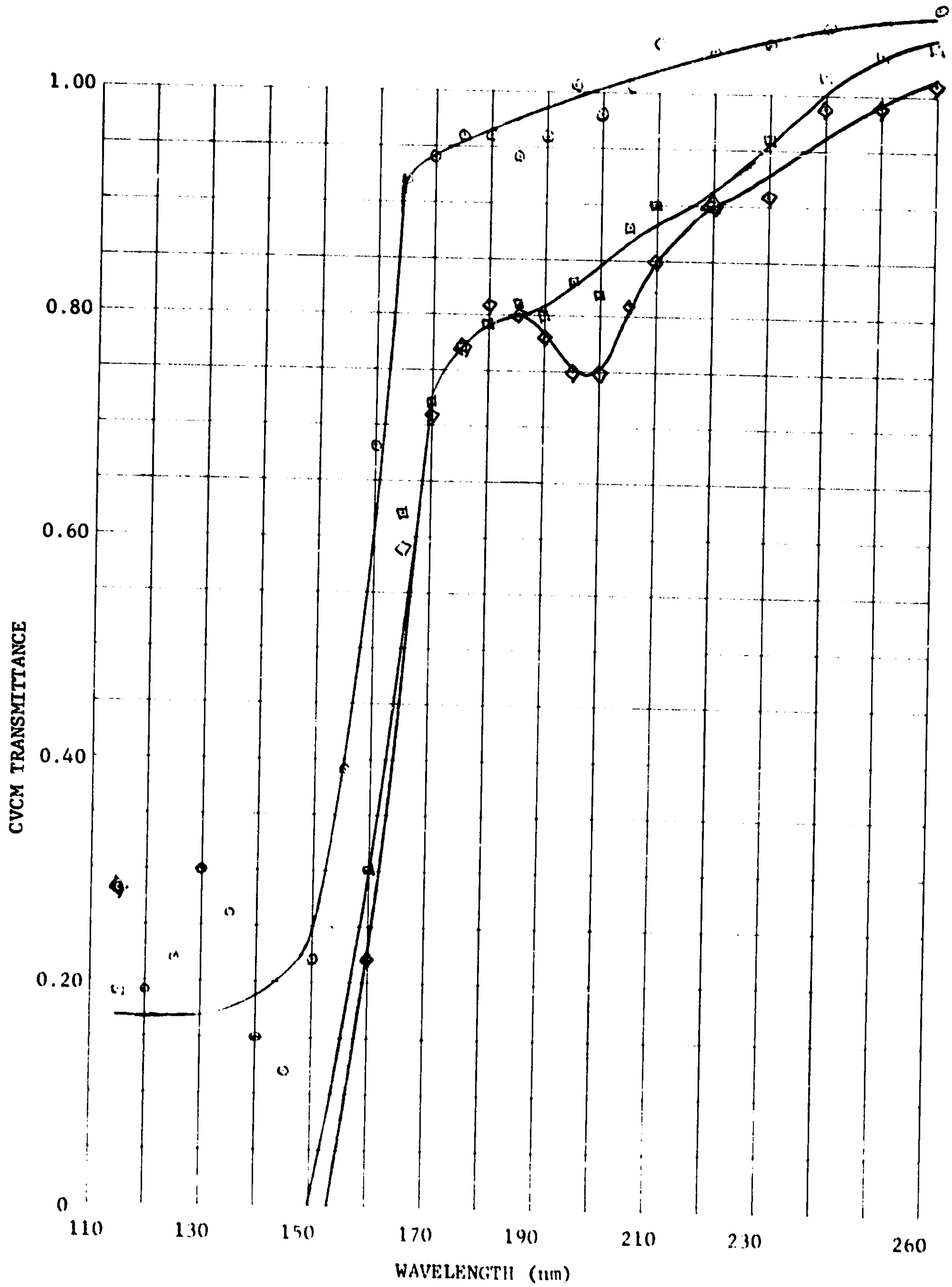

Figure 9. CVCM Transmittance Versus Wavelength, Source Material Trabond BB-2116, CVCM Thickness In Angstroms ○ 72, □ 151, ◇ 208.

Table XLIV. CVCM Transmittance Versus Wavelength, Source Material Trabond BB-2116, Source Temperature 49°C, MgF_2 Window Temperature -76°C, Chamber Pressure 3×10^{-6} Torr.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3
115	0.26	0.28	0.08	--	0.08	--
120	0.17	0.19	0.02	--	0.02	--
125	0.20	0.22	0.02	--	0.02	--
130	0.28	0.30	0.02	--	0.02	--
135	0.24	0.26	0.01	--	0.01	--
140	0.13	0.15	0.00	--	0.01	--
145	0.11	0.12	0.00	--	0.00	--
150	0.21	0.22	0.00	--	0.00	--
155	0.38	0.39	0.03	--	0.02	--
160	0.68	0.68	0.26	0.30	0.14	0.22
165	0.91	0.92	0.58	0.62	0.51	0.59
170	0.93	0.94	0.68	0.72	0.63	0.71
175	0.95	0.96	0.73	0.77	0.69	0.77
180	0.95	0.96	0.75	0.79	0.73	0.81
185	0.9-	0.94	0.77	0.81	0.72	0.80
190	0.96	0.96	0.76	0.80	0.70	0.78
195	1.01	1.01	0.79	0.83	0.67	0.75
200	0.97	0.98	0.78	0.82	0.67	0.75
205	1.01	1.01	0.84	0.88	0.73	0.81
210	1.05	1.05	0.90	0.90	0.82	0.85
220	1.0-	1.04	0.90	0.90	0.87	0.90
230	1.05	1.05	0.96	0.96	0.88	0.91
240	1.05	1.08	1.02	1.02	0.96	0.99
250	1.08	1.08	1.04	1.04	0.99	0.99
260	1.11	1.11	1.05	1.05	1.01	1.01
270	1.11	1.11	1.05	1.05	1.02	1.02
280	1.10	1.10	1.05	1.05	1.04	1.04
290	1.05	1.05	1.00	1.00	1.01	1.01
300	1.07	1.07	1.02	1.02	1.04	1.04
CVCM THICKNESS (A)	72		151		208	
TIME AFTER 100% SCAN (min)	36		281		989	

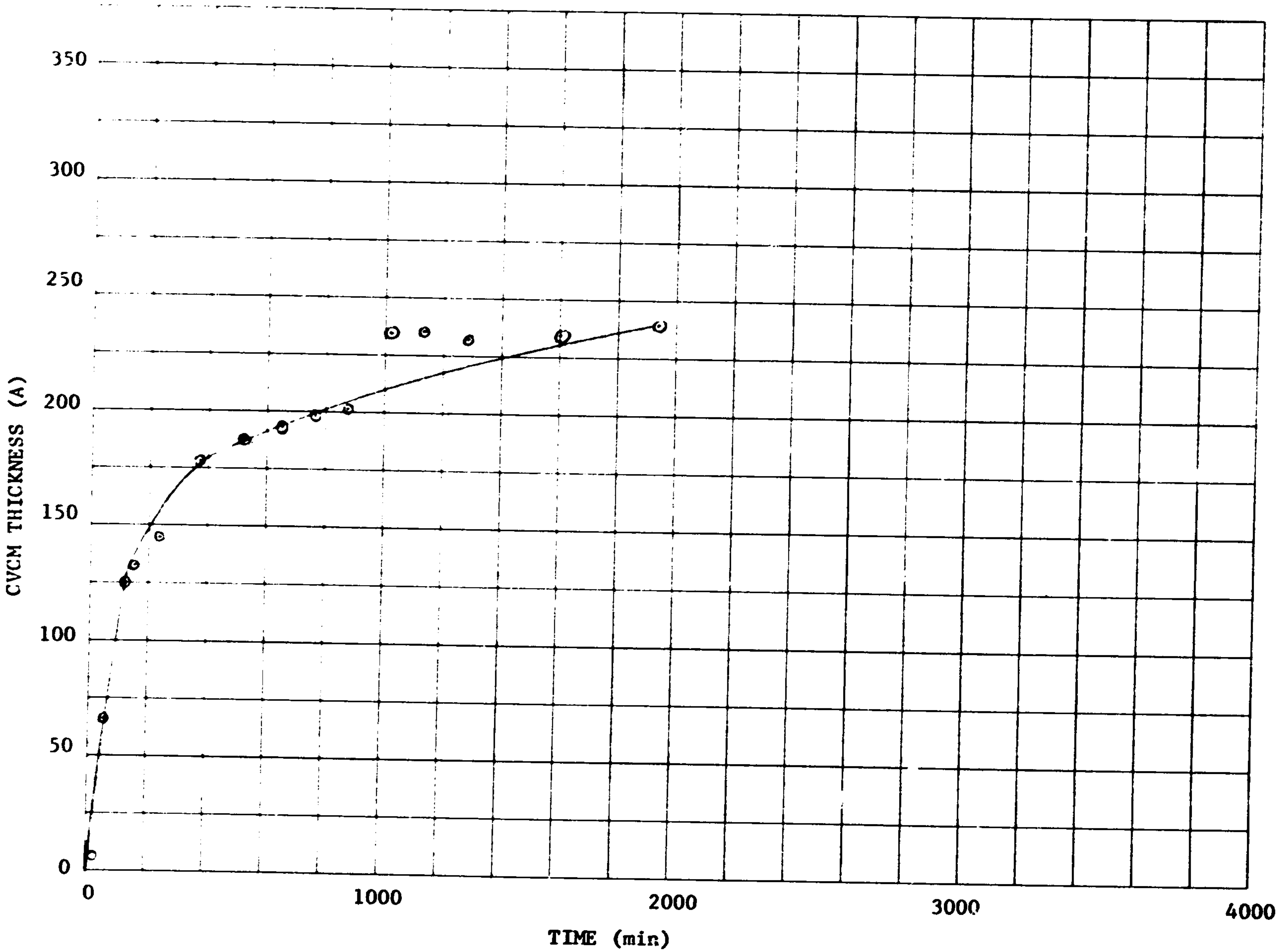

Figure 10. CVCM Thickness In Angstroms, Source Material Trabond BB-2116, Source Temperature 49°C, TQCM Temperature -82°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

EA-9309 A/B

JPL#140-VOD-1

WEIGHT: 1.8843 g

CURE: 72 HR @ AMBIENT/AMBIENT PRESSURE

SOURCE TEMPERATURE: 52°C

WINDOW TEMPERATURE: -73°C

TQCM TEMPERATURE: -65°C

COMMENTS: CVCM TRANSMITTANCE INVERSELY PROPORTIONAL TO WAVELENGTH
NO RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm
WARMED TO -40°C, NO AFFECT ON TRANSMITTANCE
AFTER TEST, AMBIENT TEMPERATURE, T = 0.40 @ 120 nm
T = 0.86 @ 300 nm

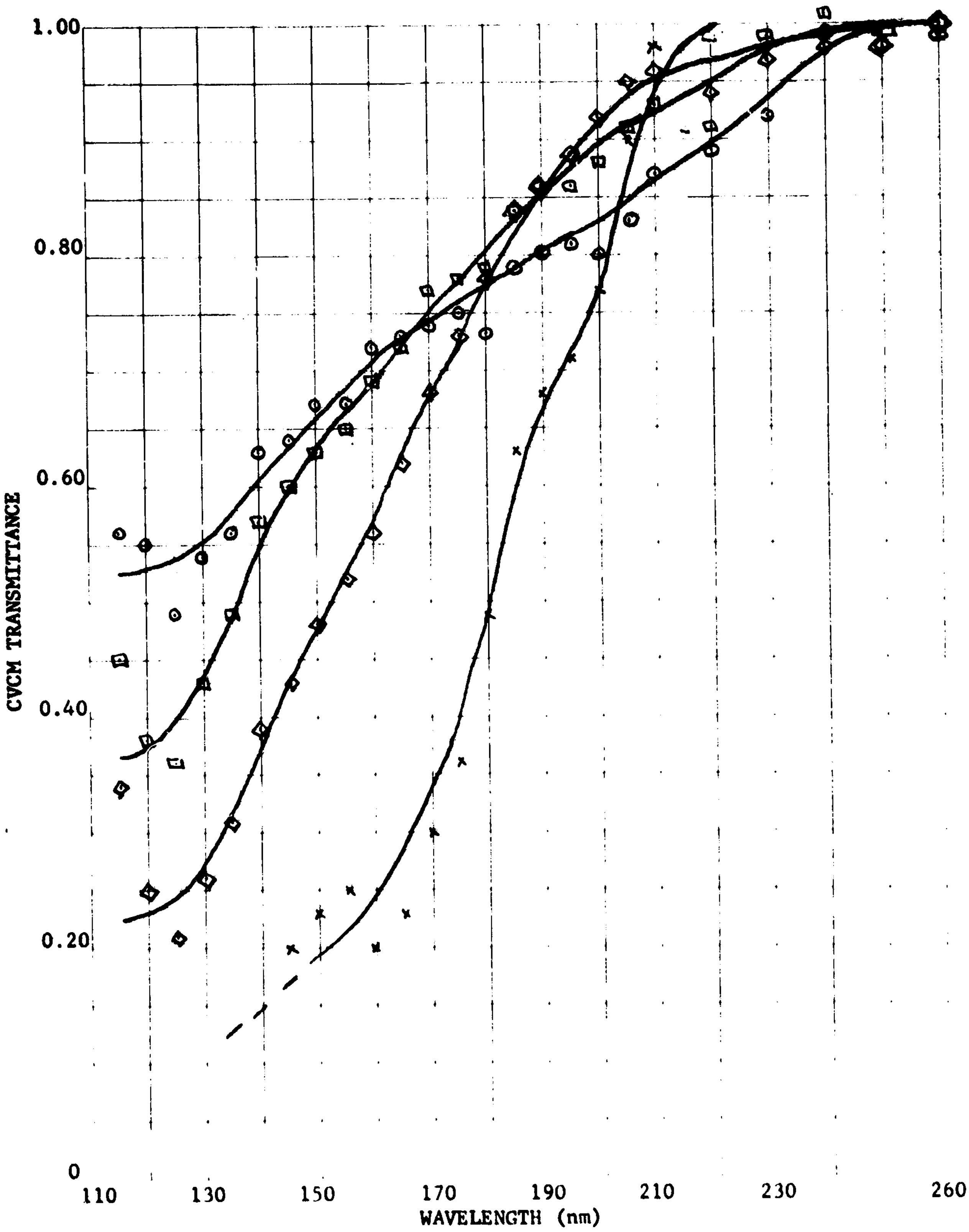

Figure 11. CVCM Transmittance Versus Wavelength, Source Material EA-9309, Ambient Cure, CVCM Thickness In Angstroms ○ 78, □ 167, ◇ 318, × 1479.

Table XLV. CVCM Transmittance Versus Wavelength, Source Material EA-9309, Ambient Cure, Source Temperature 52°C, MgF_2 Window Temperature -73°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.53	0.56	0.40	0.45	0.26	0.34	0.06	--
120	0.52	0.55	0.33	0.38	0.17	0.25	0.01	--
125	0.46	0.49	0.31	0.36	0.13	0.21	0.01	--
130	0.51	0.54	0.38	0.43	0.18	0.26	0.01	--
135	0.53	0.56	0.44	0.49	0.23	0.31	0.01	--
140	0.60	0.63	0.52	0.57	0.31	0.39	0.01	--
145	0.62	0.64	0.57	0.60	0.38	0.43	0.02	0.20
150	0.65	0.67	0.60	0.63	0.43	0.48	0.05	0.23
155	0.65	0.67	0.62	0.65	0.47	0.52	0.07	0.25
160	0.72	0.72	0.68	0.69	0.54	0.56	0.10	0.20
165	0.73	0.73	0.71	0.72	0.60	0.62	0.13	0.23
170	0.74	0.74	0.76	0.77	0.66	0.68	0.20	0.30
175	0.75	0.75	0.77	0.78	0.71	0.73	0.26	0.36
180	0.73	0.73	0.78	0.79	0.76	0.78	0.39	0.49
185	0.79	0.79	0.83	0.84	0.82	0.84	0.53	0.63
190	0.80	0.80	0.85	0.86	0.84	0.86	0.58	0.68
195	0.81	0.81	0.85	0.86	0.87	0.89	0.61	0.71
200	0.80	0.80	0.87	0.88	0.90	0.92	0.67	0.77
205	0.83	0.83	0.90	0.91	0.93	0.95	0.80	0.90
210	0.87	0.87	0.93	0.93	0.96	0.96	0.93	0.98
220	0.89	0.89	0.91	0.91	0.94	0.94	1.03	1.08
230	0.92	0.92	0.99	0.99	0.97	0.97	1.18	1.23
240	0.99	0.99	1.01	1.01	0.98	0.98	1.18	1.23
250	0.98	0.98	0.99	0.99	0.98	0.98	1.16	1.16
260	0.99	0.99	1.00	1.00	1.00	1.00	1.20	1.20
270	1.03	1.03	0.98	0.98	1.03	1.03	1.26	1.26
280	1.03	1.03	0.98	0.98	1.03	1.03	1.26	1.26
290	1.06	1.06	0.97	0.97	1.03	1.03	1.24	1.24
300	1.06	1.06	1.00	1.00	1.07	1.07	1.28	1.28
CVCM THICKNESS (A)	78		167		318		1479	
TIME AFTER 100% SCAN (min)	42		93		159		1112	

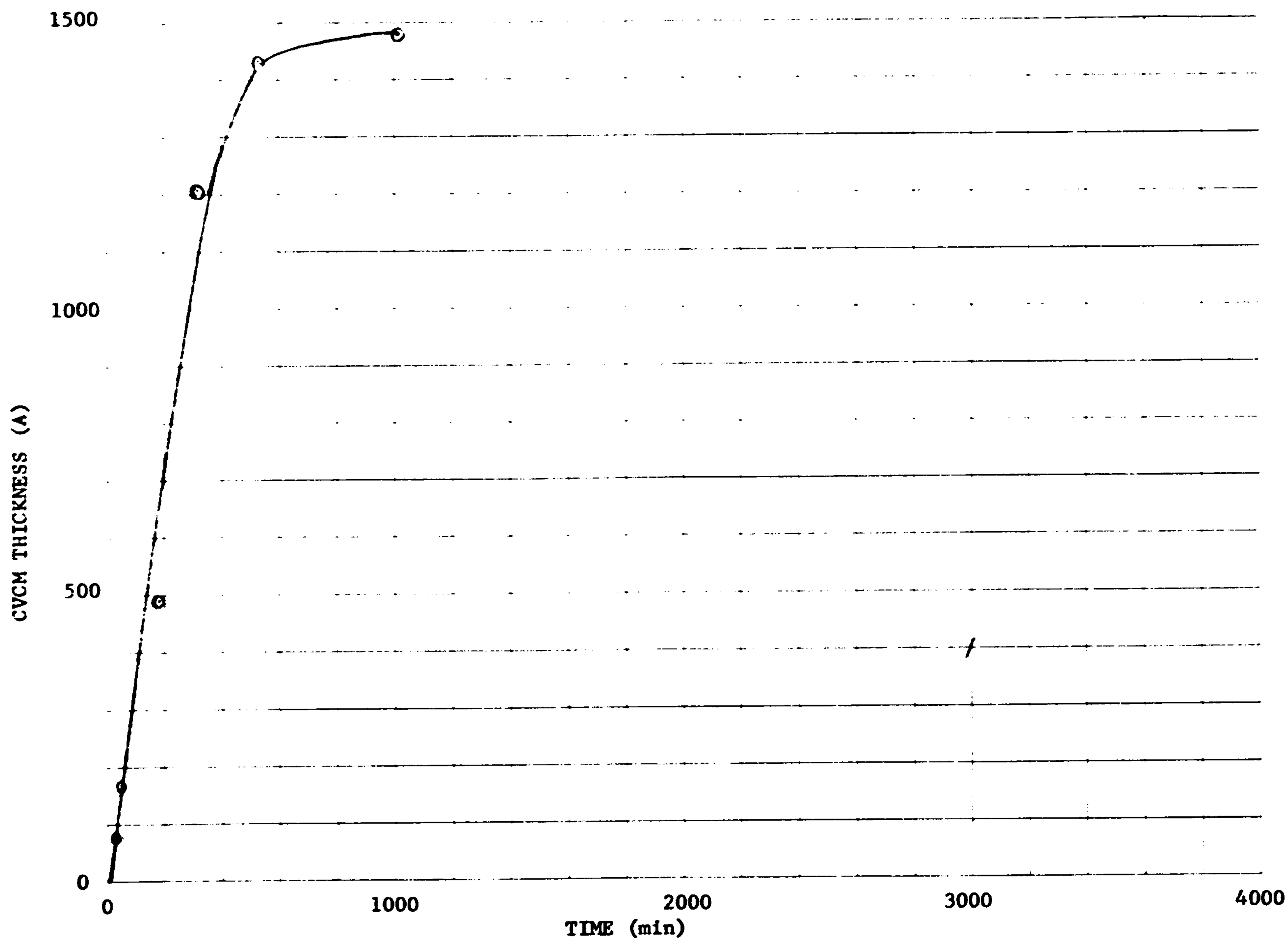

Figure 12. CVCM Thickness In Angstroms, Source Material EA-9309, Ambient Cure, Source Temperature 52°C, TQCM Temperature -65°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

EA-9309 A/B

JPL#140-VOD-2

WEIGHT: 2.1798 g

CURE: 10 HR @ AMBIENT, 5 HR @ 125°F; AMBIENT PRESSURE

SOURCE TEMPERATURE: 63°C

WINDOW TEMPERATURE: -84°C

TQCM TEMPERATURE: -81°C

COMMENTS: CVCM TRANSMITTANCE INVERSELY PROPORATIONAL TO WAVELENGTH

AFTER TEST, AMBIENT TEMPERATURE, T = 0.52 @ 120 nm

VISIBLE CONTAMINANT ON SURFACE, AMBIENT TEMPERATURE AND PRESSURE

ADDITIONAL CURE OF 5 HR @ 125°F DID NOT AFFECT DEGREE OF CVCM DEPOSITION

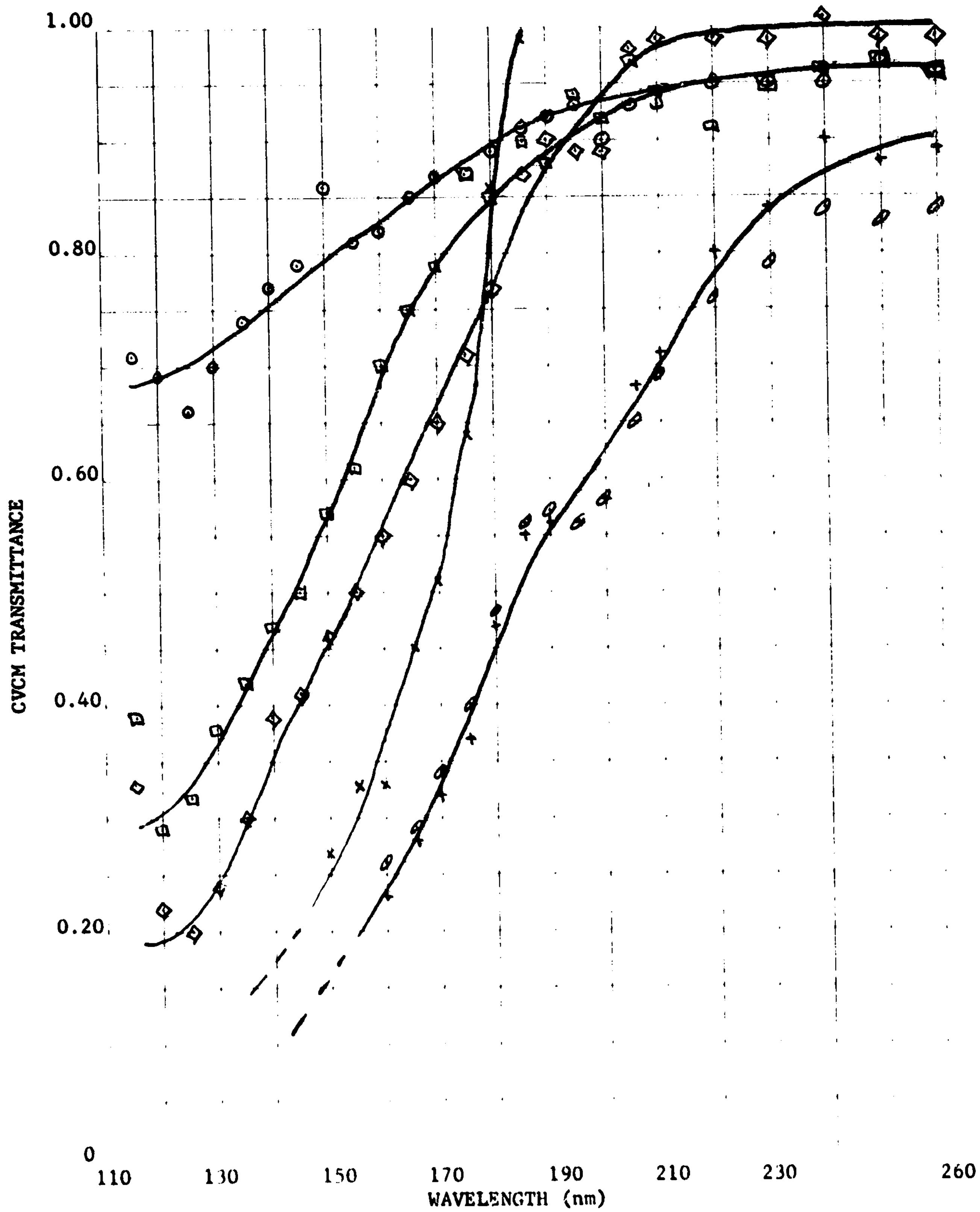

Figure 13. CVCM Transmittance Versus Wavelength, Source Material EA-9309, Cured 10 Hr Ambient/5 Hr 125°F, CVCM Thickness ⊙ 110, ⊡ 284, ◇ 472, × 1522, + 1547, ⌀ 1565 Å.

Table XLVI. CVCM Transmittance Versus Wavelength, Source Material EA-9309, Cured 10 Hrs Ambient/ 5 Hrs 125°F, Source Temperature 63°C, MgF_2 Window Temperature -84°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5	T	T_6
115	0.69	0.71	0.33	0.39	0.25	0.33	0.03	--	0.04	--	0.06	--
120	0.67	0.69	0.23	0.29	0.14	0.22	0.03	--	0.02	--	0.02	--
125	0.64	0.66	0.26	0.32	0.12	0.20	0.02	--	0.01	--	0.01	--
130	0.68	0.70	0.32	0.38	0.16	0.24	0.03	--	0.01	--	0.01	--
135	0.72	0.74	0.36	0.42	0.22	0.30	0.02	--	0.01	--	0.01	--
140	0.75	0.77	0.41	0.47	0.31	0.39	0.04	--	0.01	--	0.01	--
145	0.78	0.79	0.47	0.50	0.36	0.41	0.07	--	0.03	--	0.02	--
150	0.85	0.86	0.54	0.57	0.41	0.46	0.10	0.27	0.05	--	0.03	--
155	0.80	0.81	0.58	0.61	0.45	0.50	0.16	0.33	0.06	--	0.05	--
160	0.82	0.82	0.69	0.70	0.53	0.55	0.23	0.33	0.09	0.23	0.07	0.26
165	0.85	0.85	0.74	0.75	0.58	0.60	0.35	0.45	0.14	0.28	0.10	0.29
170	0.87	0.87	0.78	0.79	0.63	0.65	0.41	0.51	0.18	0.32	0.15	0.34
175	0.87	0.87	0.86	0.87	0.69	0.71	0.54	0.64	0.23	0.37	0.21	0.40
180	0.89	0.89	0.84	0.85	0.75	0.77	0.76	0.86	0.33	0.47	0.29	0.48
185	0.91	0.91	0.89	0.90	0.85	0.87	0.89	0.99	0.41	0.55	0.37	0.56
190	0.92	0.92	0.87	0.88	0.88	0.90	0.94	1.04	0.42	0.56	0.38	0.57
195	0.93	0.93	0.93	0.94	0.87	0.89	0.95	1.05	0.42	0.56	0.37	0.56
200	0.90	0.90	0.91	0.92	0.87	0.89	1.05	1.15	0.44	0.58	0.39	0.58
205	0.93	0.93	0.96	0.97	0.96	0.98	1.27	1.37	0.54	0.68	0.46	0.65
210	0.93	0.93	0.94	0.94	0.99	0.99	1.18	1.22	0.63	0.71	0.59	0.69
220	0.95	0.95	0.91	0.91	0.99	0.99	1.39	1.43	0.72	0.80	0.66	0.76
230	0.95	0.95	0.95	0.95	0.99	0.99	1.38	1.42	0.76	0.84	0.69	0.79
240	0.95	0.95	0.96	0.96	1.01	1.01	1.36	1.40	0.82	0.90	0.74	0.84
250	0.97	0.97	0.97	0.97	0.99	0.99	1.36	1.36	0.88	0.88	0.83	0.83
260	0.96	0.96	0.96	0.96	0.99	0.99	1.36	1.36	0.89	0.89	0.84	0.84
270	0.96	0.96	0.96	0.96	0.96	0.96	1.37	1.37	0.89	0.89	0.85	0.85
280	0.97	0.97	0.98	0.98	1.00	1.00	1.39	1.39	0.92	0.92	0.87	0.87
290	0.98	0.98	1.01	1.01	0.99	0.99	1.40	1.40	0.96	0.96	0.88	0.88
300	1.00	1.00	0.96	0.96	0.99	0.99	1.38	1.38	0.94	0.94	0.89	0.89
CVCM THICKNESS (A)	110		284		472		1522		1547		1565	
TIME AFTER 100% SCAN (min)	27		115		195		1295		2730		4164	

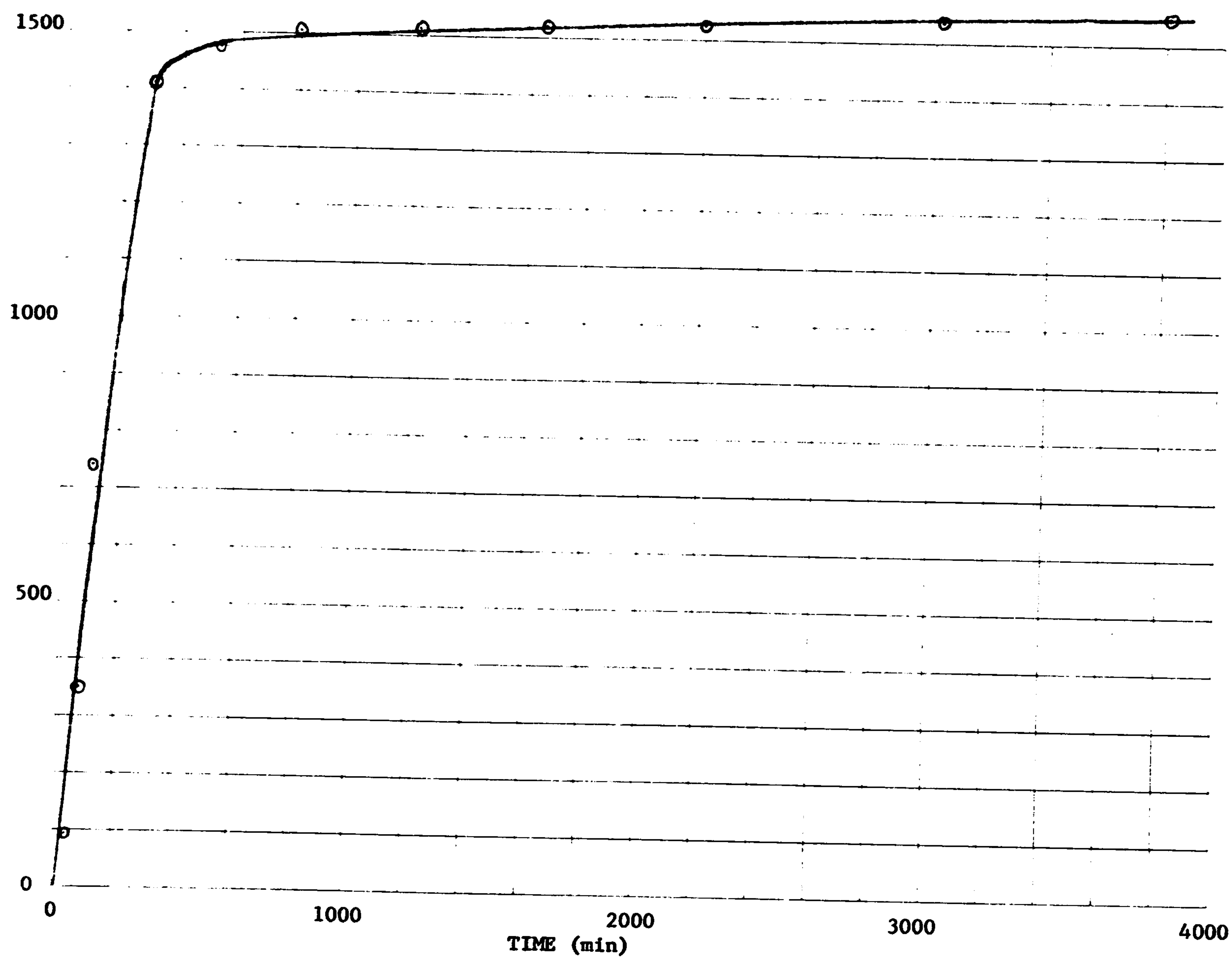

Figure 14. CVCM Thickness In Angstroms, Source Material EA-9309, Cured 10 Hr Ambient/5 Hr 125°F, Source Temperature 63°C, TQCM Temperature -81°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

EA-9309 A/B

JPL#140-VOD-3

WEIGHT: 0.8147 g

CURE: 1 HR @ 180°F; AMBIENT PRESSURE
24 HR @ 176°F; VACUUM

SOURCE TEMPERATURE: 57°C

WINDOW TEMPERATURE: -79°C

TQCM TEMPERATURE: -82°C

COMMENTS: RELATIVELY LOW OUTGASSING MATERIAL WHEN CURED IN VACUUM

21 TIMES LESS DEPOSITION FOR 2.7 TIMES LESS WEIGHT AFTER VACUUM BAKE

AFTER TEST, AMBIENT TEMPERATURE T = 0.77 @ 120 nm
T = 0.93 @ 300 nm

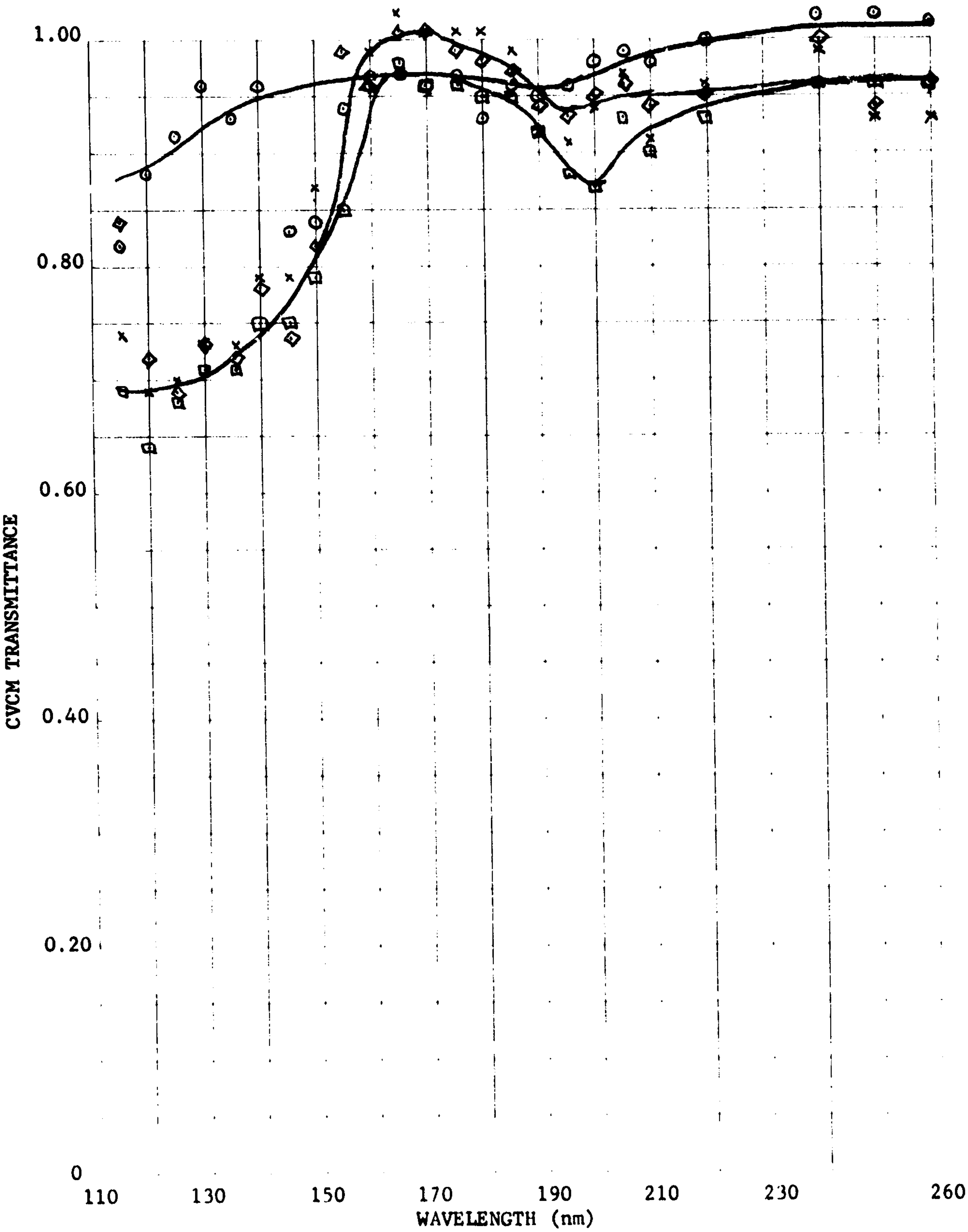

Figure 15. CVCM Transmittance Versus Wavelength, Source Material EA-9309, JPL#140-VOD-3, CVCM Thickness In Angstroms ⊙ 25, ⊡ 51, ◇ 71, × 70.

Table XLVII. CVCM Transmittance Versus Wavelength, Source Material EA-9309 A/B JPL #140-VOD-3, Source Temperature 57°C, MgF_2 Window Temperature -79°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.76	0.82	0.48	0.63	0.51	0.84	0.32	0.74
120	0.70	0.88	0.43	0.64	0.39	0.72	0.27	0.69
125	0.74	0.92	0.47	0.68	0.36	0.69	0.28	0.70
130	0.78	0.96	0.50	0.71	0.40	0.73	0.31	0.73
135	0.75	0.93	0.50	0.71	0.39	0.72	0.31	0.73
140	0.78	0.96	0.54	0.75	0.45	0.78	0.37	0.79
145	0.80	0.83	0.59	0.75	0.47	0.74	0.43	0.79
150	0.81	0.84	0.63	0.79	0.55	0.82	0.51	0.87
155	0.91	0.94	0.77	0.85	0.72	0.99	0.70	1.06
160	0.96	0.97	0.87	0.96	0.82	0.96	0.81	0.99
165	0.96	0.97	0.89	0.98	0.87	1.01	0.85	1.03
170	0.95	0.96	0.87	0.96	0.87	1.01	0.83	1.01
175	0.96	0.97	0.87	0.96	0.85	0.99	0.83	1.01
180	0.92	0.93	0.86	0.95	0.84	0.98	0.83	1.01
185	0.95	0.96	0.86	0.95	0.83	0.97	0.81	0.99
190	0.94	0.95	0.83	0.92	0.80	0.94	0.74	0.92
195	0.95	0.96	0.79	0.88	0.79	0.93	0.73	0.91
200	0.97	0.98	0.78	0.87	0.81	0.95	0.76	0.94
205	0.98	0.99	0.84	0.93	0.82	0.96	0.79	0.97
210	0.98	0.98	0.87	0.90	0.86	0.94	0.81	0.91
220	1.00	1.00	0.90	0.93	0.87	0.95	0.86	0.96
230	1.14	1.14	1.04	1.07	1.04	1.12	1.00	1.10
240	1.03	1.03	0.93	0.96	0.92	1.00	0.89	0.99
250	1.03	1.03	0.96	0.96	0.94	0.94	0.93	0.93
260	1.02	1.02	0.96	0.96	0.96	0.96	0.93	0.93
270	1.09	1.09	1.02	1.02	1.02	1.02	0.98	0.98
280	1.06	1.06	1.01	1.01	1.03	1.03	0.98	0.98
290	1.06	1.06	1.01	1.01	1.00	1.00	0.98	0.98
300	0.99	0.99	0.94	0.94	0.96	0.96	0.94	0.94
CVCM THICKNESS (A)	25		51		71		70	
TIME AFTER 100% SCAN (min)	110		1145		2676		3990	

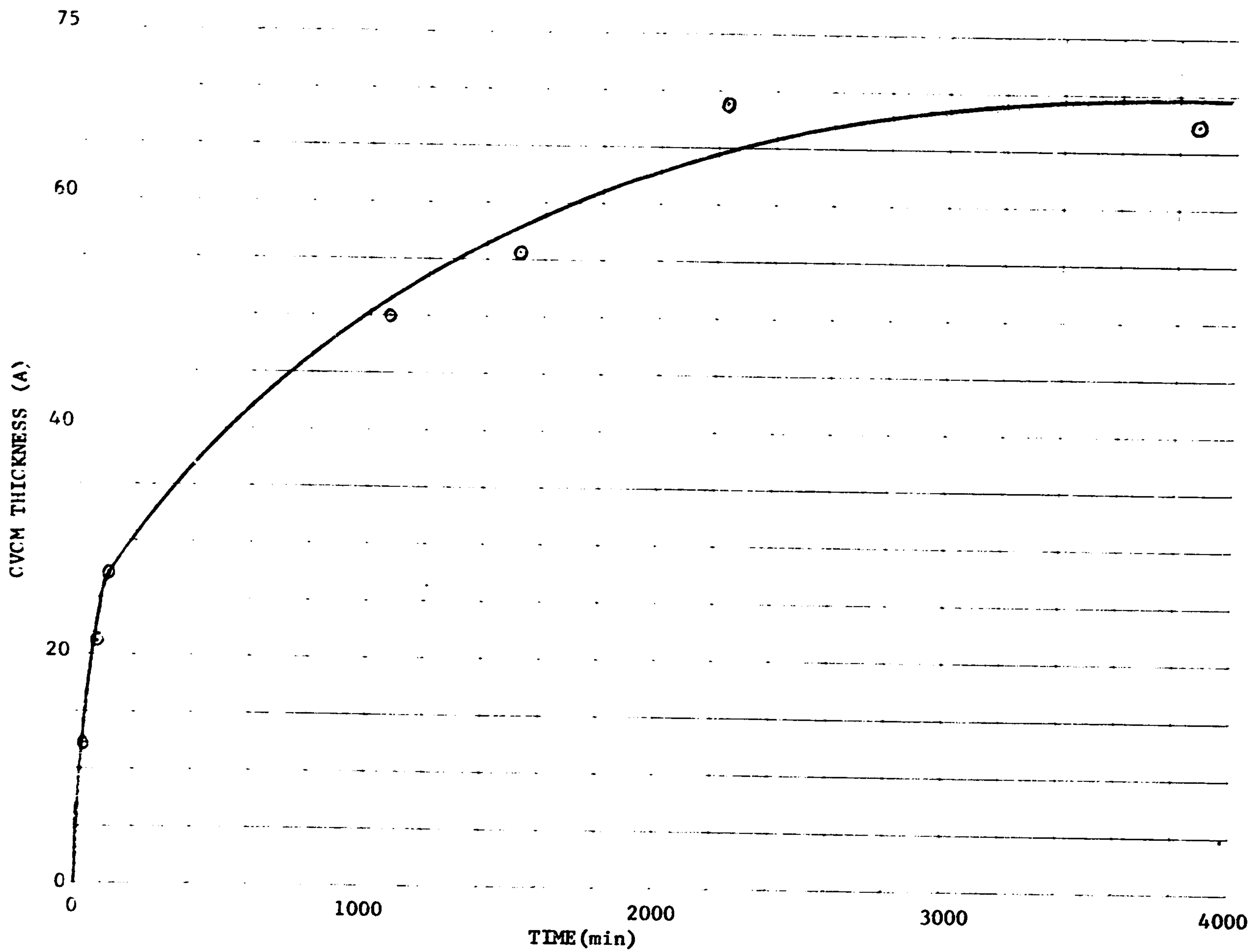

Figure 16. CVCM Thickness In Angstroms, Source Material EA-9309 A/B, JPL#140-VOD-3, Source Temperature 57°C, TQCM Temperature -82°C, TQCM Sensitivity 1.56×10^{-9} g.cm^{-2}.Hz^{-1}, CVCM Specific Gravity Assumed To Be 1.0.

SCOTCHWELD 2216 B/A CLEAR

JPL#31-VOD-1

WEIGHT: 1.5187 g

CURE: 24 HR @ AMBIENT; AMBIENT PRESSURE

SOURCE TEMPERATURE: 64°C

WINDOW TEMPERATURE: -79°C

TQCM TEMPERATURE: -82°C

COMMENTS: CVCM TRANSMITTANCE INVERSELY PROPORTIONAL TO WAVELENGTH
RELATIVE MINIMUM IN TRANSMITTANCE NEAR 195 nm
WARMED TO -40°C, NO AFFECT ON TRANSMITTANCE
AFTER TEST, AMBIENT TEMPERATURE, T = 0.88 @ 120 nm
T = 0.98 @ 300 nm

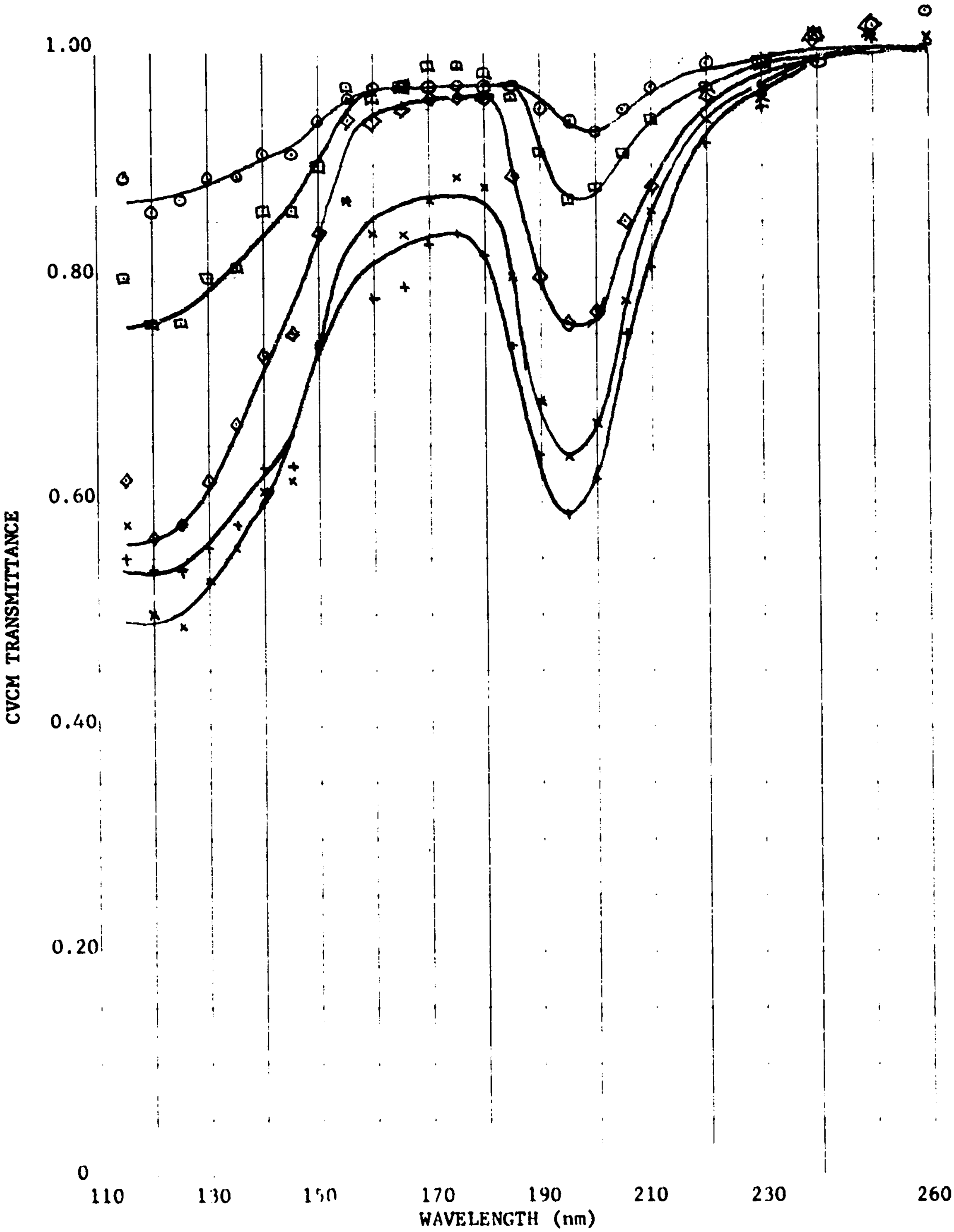

Figure 17. CVCM Transmittance Versus Wavelength, Source Material Scotch-Weld 2216, Ambient Cured, CVCM Thickness ⊕ 26, ⊡ 68, ◇ 147, × 250, + 303.

Table XLVIII. CVCM Transmittance Versus Wavelength, Source Material Scotchweld 2216, Cured Ambient Temperature, Source Temperature 64°C, MgF_2 Window Temperature -79°C, Chamber Pressure $2x10^{-5}$ Torr.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5
115	0.85	0.89	0.69	0.80	0.39	0.62	0.24	0.58	0.11	0.55
120	0.82	0.86	0.65	0.76	0.34	0.57	0.16	0.50	0.10	0.54
125	0.83	0.87	0.65	0.76	0.35	0.58	0.15	0.49	0.10	0.54
130	0.85	0.89	0.69	0.80	0.39	0.62	0.19	0.53	0.12	0.56
135	0.85	0.89	0.70	0.81	0.44	0.67	0.22	0.56	0.14	0.58
140	0.87	0.91	0.75	0.86	0.50	0.73	0.27	0.61	0.19	0.63
145	0.89	0.91	0.79	0.86	0.58	0.75	0.34	0.62	0.25	0.63
150	0.92	0.94	0.83	0.90	0.67	0.84	0.46	0.74	0.36	0.74
155	0.94	0.96	0.90	0.97	0.77	0.94	0.59	0.87	0.49	0.87
160	0.96	0.97	0.93	0.96	0.84	0.94	0.70	0.84	0.59	0.78
165	0.96	0.97	0.94	0.97	0.85	0.95	0.70	0.84	0.60	0.79
170	0.96	0.97	0.96	0.99	0.86	0.96	0.73	0.87	0.64	0.83
175	0.96	0.97	0.96	0.99	0.86	0.96	0.75	0.89	0.65	0.84
180	0.96	0.97	0.95	0.98	0.86	0.96	0.74	0.88	0.63	0.82
185	0.96	0.97	0.93	0.96	0.79	0.89	0.66	0.80	0.55	0.74
190	0.94	0.95	0.88	0.91	0.70	0.80	0.55	0.69	0.45	0.64
195	0.93	0.94	0.84	0.87	0.66	0.76	0.50	0.64	0.40	0.59
200	0.92	0.93	0.85	0.88	0.67	0.77	0.53	0.67	0.43	0.62
205	0.94	0.95	0.88	0.91	0.75	0.85	0.64	0.78	0.56	0.75
210	0.97	0.97	0.94	0.94	0.83	0.88	0.78	0.86	0.71	0.81
220	0.99	0.99	0.97	0.97	0.91	0.96	0.86	0.94	0.82	0.92
230	0.99	0.99	0.99	0.99	0.92	0.97	0.88	0.96	0.85	0.95
240	0.99	0.99	1.02	1.02	0.97	1.02	0.94	1.02	0.94	1.04
250	1.03	1.03	1.06	1.06	1.03	1.03	1.02	1.02	1.02	1.02
260	1.04	1.04	1.06	1.06	1.05	1.05	1.02	1.02	1.01	1.01
270	1.04	1.04	1.07	1.07	1.05	1.05	1.03	1.03	1.02	1.02
280	1.04	1.04	1.03	1.03	1.04	1.04	1.03	1.03	1.00	1.00
290	1.04	1.04	1.04	1.04	1.08	1.08	1.03	1.03	1.04	1.04
300	1.05	1.05	1.04	1.04	1.09	1.09	1.07	1.07	1.05	1.05
CVCM THICKNESS (A)	26		68		147		250		303	
TIME AFTER 100% SCAN (min)	59		306		1345		2780		4209	

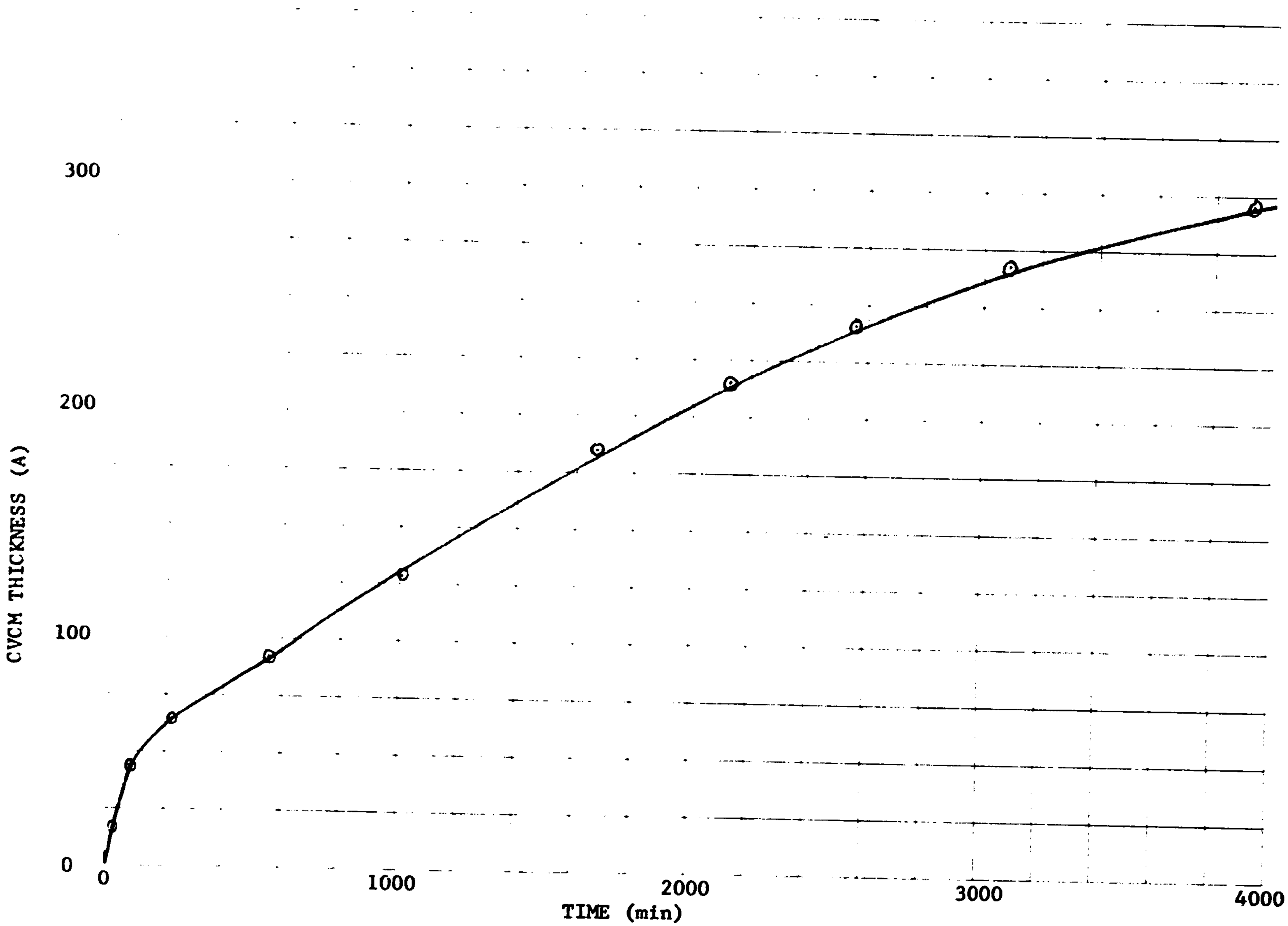

Figure 18. CVCM Thickness In Angstroms, Source Material Scotch-Weld 2216, Ambient Cure, Source Temperature 64°C, TQCM Temperature -82°C, TQCM Sensitivity 1.56×10^{-9} g.cm^{-2}.Hz^{-1}, CVCM Specific Gravity Assumed To Be 1.0.

SCOTCHWELD 2216 B/A CLEAR

JPL#31-VOD-2

WEIGHT: 1.6967 g

CURE: 9 HR @ AMBIENT; 5 HR @ 125°F; AMBIENT PRESSURE

SOURCE TEMPERATURE: 56°C

WINDOW TEMPERATURE: -79°C

TQCM TEMPERATURE: -80°C

COMMENTS: RELATIVELY LITTLE CHANGE IN TRANSMITTANCE WHEN CVCM THICKNESS IS INCREASED 3.4 TIMES

RELATIVE MINIMUM IN TRANSMITTANCE NEAR 195 nm

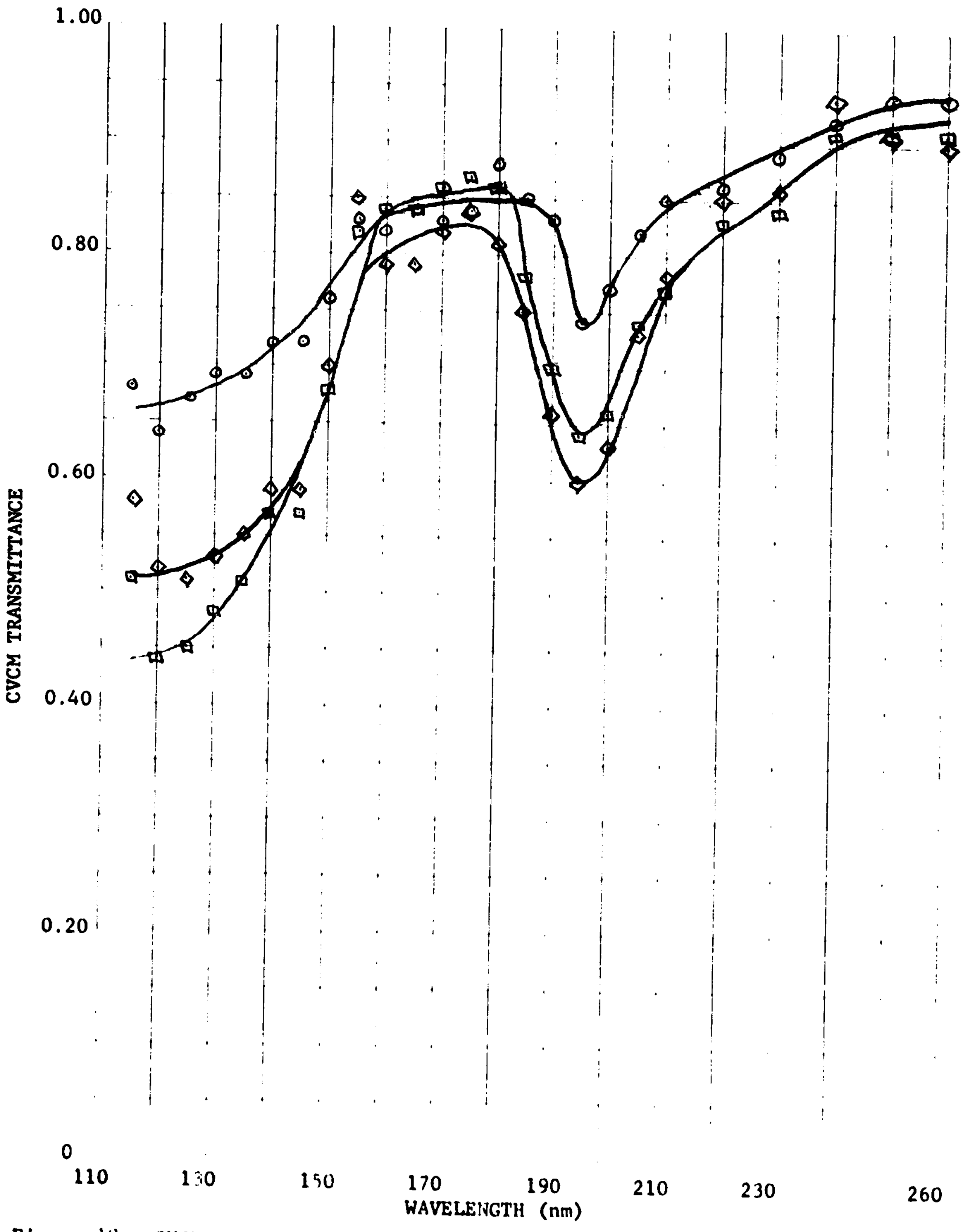

Figure 19. CVCM Transmittance Versus Wavelength, Source Material Scotch-Weld 2216, Cured 9 Hr Ambient/5 Hr 125°F, CVCM Thickness ○ 57, □ 160, ◇ 193.

Table XLIX. CVCM Transmittance Versus Wavelength, Source Material Scotchweld 2216, Cured 9 Hr Ambient/5 Hr 125°F, Source Temperature 56°C, MgF_2 Window Temperature -72°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3
115	0.59	0.68	0.29	0.51	0.20	0.58
120	0.55	0.64	0.22	0.44	0.14	0.52
125	0.58	0.67	0.23	0.45	0.13	0.51
130	0.60	0.69	0.26	0.48	0.15	0.53
135	0.60	0.69	0.29	0.51	0.17	0.55
140	0.63	0.72	0.35	0.57	0.21	0.59
145	0.66	0.72	0.41	0.57	0.27	0.59
150	0.70	0.76	0.52	0.68	0.38	0.70
155	0.77	0.83	0.66	0.82	0.53	0.85
160	0.79	0.82	0.74	0.84	0.63	0.79
165	0.81	0.84	0.74	0.84	0.63	0.79
170	0.80	0.83	0.76	0.86	0.66	0.82
175	0.81	0.84	0.77	0.87	0.67	0.83
180	0.85	0.88	0.76	0.86	0.65	0.81
185	0.82	0.85	0.68	0.78	0.59	0.75
190	0.80	0.83	0.60	0.70	0.50	0.66
195	0.71	0.74	0.54	0.64	0.44	0.60
200	0.74	0.77	0.56	0.66	0.47	0.63
205	0.79	0.82	0.64	0.74	0.57	0.73
210	0.85	0.85	0.73	0.77	0.69	0.78
220	0.86	0.86	0.79	0.83	0.76	0.85
230	0.89	0.89	0.80	0.84	0.77	0.86
240	0.92	0.92	0.87	0.91	0.85	0.94
250	0.94	0.94	0.91	0.91	0.91	0.91
260	0.94	0.94	0.91	0.91	0.90	0.90
270	0.94	0.94	0.89	0.89	0.89	0.89
280	0.90	0.90	0.91	0.91	0.89	0.89
290	0.92	0.92	0.95	0.95	0.94	0.94
300	0.92	0.92	0.98	0.98	0.96	0.96
CVCM THICKNESS (A)	57		160		193	
TIME AFTER 100% SCAN (min)	230		1250		3267	

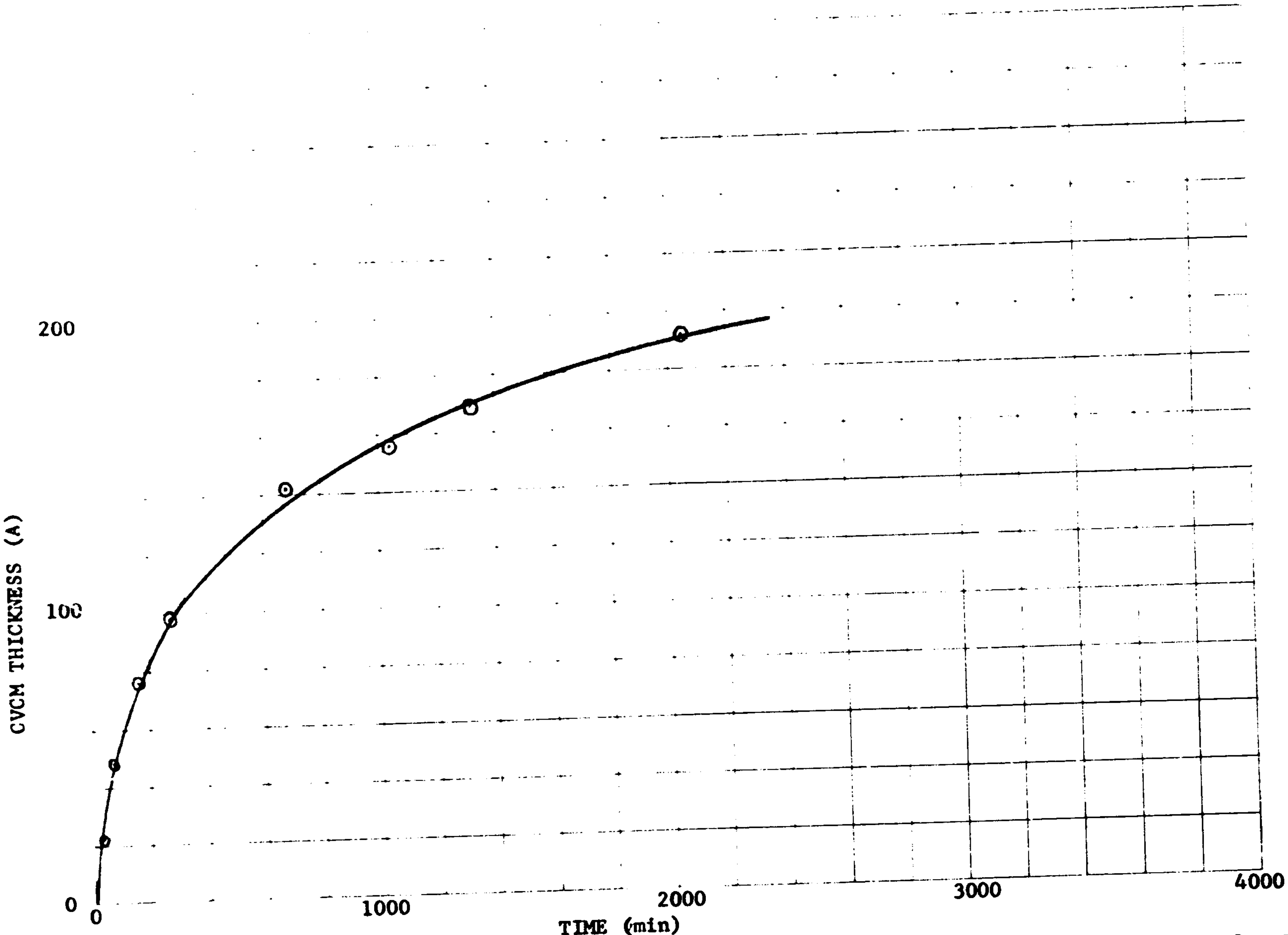

Figure 20. CVCM Thickness In Angstroms, Source Material Scotch-Weld 2216, Cured 9 Hr Ambient/5 Hr 125°F, Source Temperature 56°C, TQCM Temperature -73°C, TQCM Sensitivity $1.56 \times 10^{-9} g.cm^{-2}.Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

SCOTCHWELD 2216 B/A CLEAR

JPL#31-VOD-3

WEIGHT: ABOUT 1.5935 g
SUBSTRATE NOT MEASURED, ASSUME AVERAGE 81.3700 g

CURE: 9 HR @ AMBIENT, 4 HR @ 125°F; AMBIENT PRESSURE
24 HR @ 176°F; VACUUM

SOURCE TEMPERATURE: 56°C

WINDOW TEMPERATURE: -79°C

TQCM TEMPERATURE: -80°C

COMMENTS: RELATIVELY LITTLE CHANGE IN TRANSMITTANCE WHEN CVCM THICKNESS IS DOUBLED

VACUUM BAKE REDUCES DEPOSITION BY MORE THAN A FACTOR OF 2

WARMED TO -40°C PRODUCES A SLIGHT INCREASE (4%) IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE T = 1.00 @ 120 nm
T = 0.88 @ 300 nm

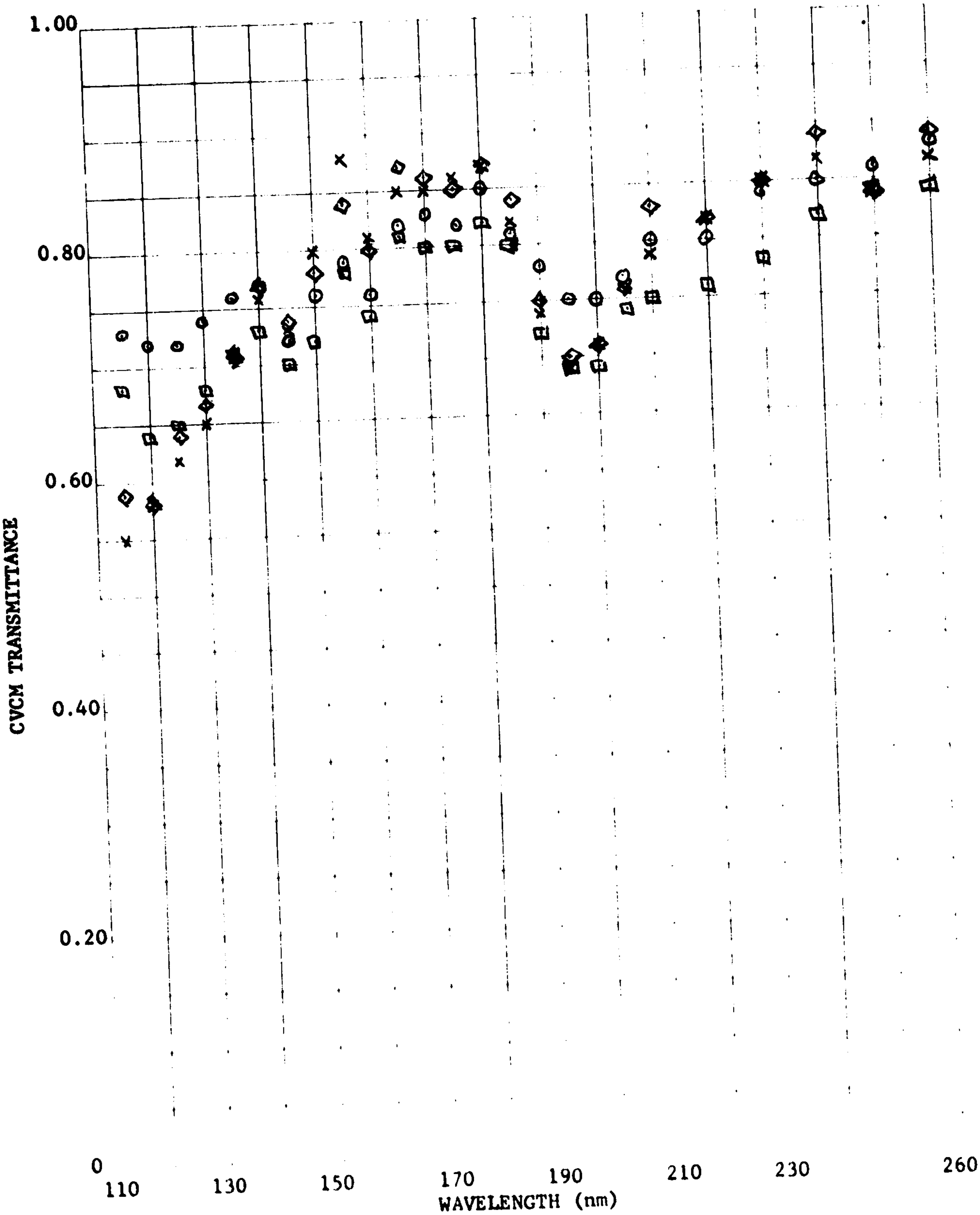

Figure 21. CVCM Transmittance Versus Wavelength, Source Material Scotch-Weld 2216, JPL#31-VOD-3, CVCM Thickness In Angstroms ⊙ 62, ⊡ 85, ◇ 131, × 137.

Table L. CVCM Transmittance Versus Wavelength, Source Material S[illegible]tch-Weld 2216, JPL #31-VOD-3, Source Temperature 56°C, MgF_2 Window Temperature -79°C, Chamber Pressure $4x10^{-6}$ Torr.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.65	0.73	0.56	0.68	0.35	0.59	0.21	0.55
120	0.64	0.72	0.52	0.64	0.34	0.58	0.24	0.58
125	0.64	0.72	0.53	0.65	0.40	0.64	0.28	0.62
130	0.66	0.74	0.56	0.68	0.43	0.67	0.31	0.65
135	0.68	0.76	0.59	0.71	0.47	0.71	0.37	0.71
140	0.69	0.77	0.61	0.73	0.53	0.77	0.42	0.76
145	0.67	0.72	0.62	0.70	0.56	0.74	0.45	0.73
150	0.71	0.76	0.64	0.72	0.60	0.78	0.52	0.80
155	0.74	0.79	0.70	0.78	0.66	0.84	0.60	0.88
160	0.74	0.76	0.70	0.74	0.70	0.80	0.67	0.81
165	0.80	0.82	0.77	0.81	0.77	0.87	0.71	0.85
170	0.81	0.83	0.76	0.80	0.76	0.86	0.71	0.85
175	0.80	0.82	0.76	0.80	0.75	0.85	0.72	0.86
180	0.83	0.85	0.78	0.82	0.77	0.87	0.73	0.87
185	0.79	0.81	0.76	0.80	0.74	0.84	0.68	0.82
190	0.76	0.78	0.68	0.72	0.65	0.75	0.60	0.74
195	0.73	0.75	0.65	0.69	0.60	0.70	0.55	0.69
200	0.73	0.75	0.65	0.69	0.61	0.71	0.57	0.71
205	0.75	0.77	0.70	0.74	0.66	0.76	0.62	0.76
210	0.80	0.80	0.75	0.75	0.78	0.83	0.71	0.79
220	0.80	0.80	0.76	0.76	0.77	0.82	0.74	0.82
230	0.84	0.84	0.78	0.78	0.80	0.85	0.77	0.85
240	0.85	0.85	0.82	0.82	0.84	0.89	0.79	0.87
250	0.86	0.86	0.84	0.84	0.84	0.84	0.84	0.84
260	0.88	0.88	0.84	0.84	0.89	0.89	0.87	0.87
270	0.89	0.89	0.87	0.87	0.90	0.90	0.88	0.88
280	0.90	0.90	0.87	0.87	0.90	0.90	0.87	0.87
290	0.90	0.90	0.87	0.87	0.92	0.92	0.89	0.89
300	0.92	0.92	0.88	0.88	0.93	0.93	0.89	0.89
CVCM THICKNESS (A)	62		85		131		137	
TIME AFTER 100% SCAN (min)	192		378		1482		2837	

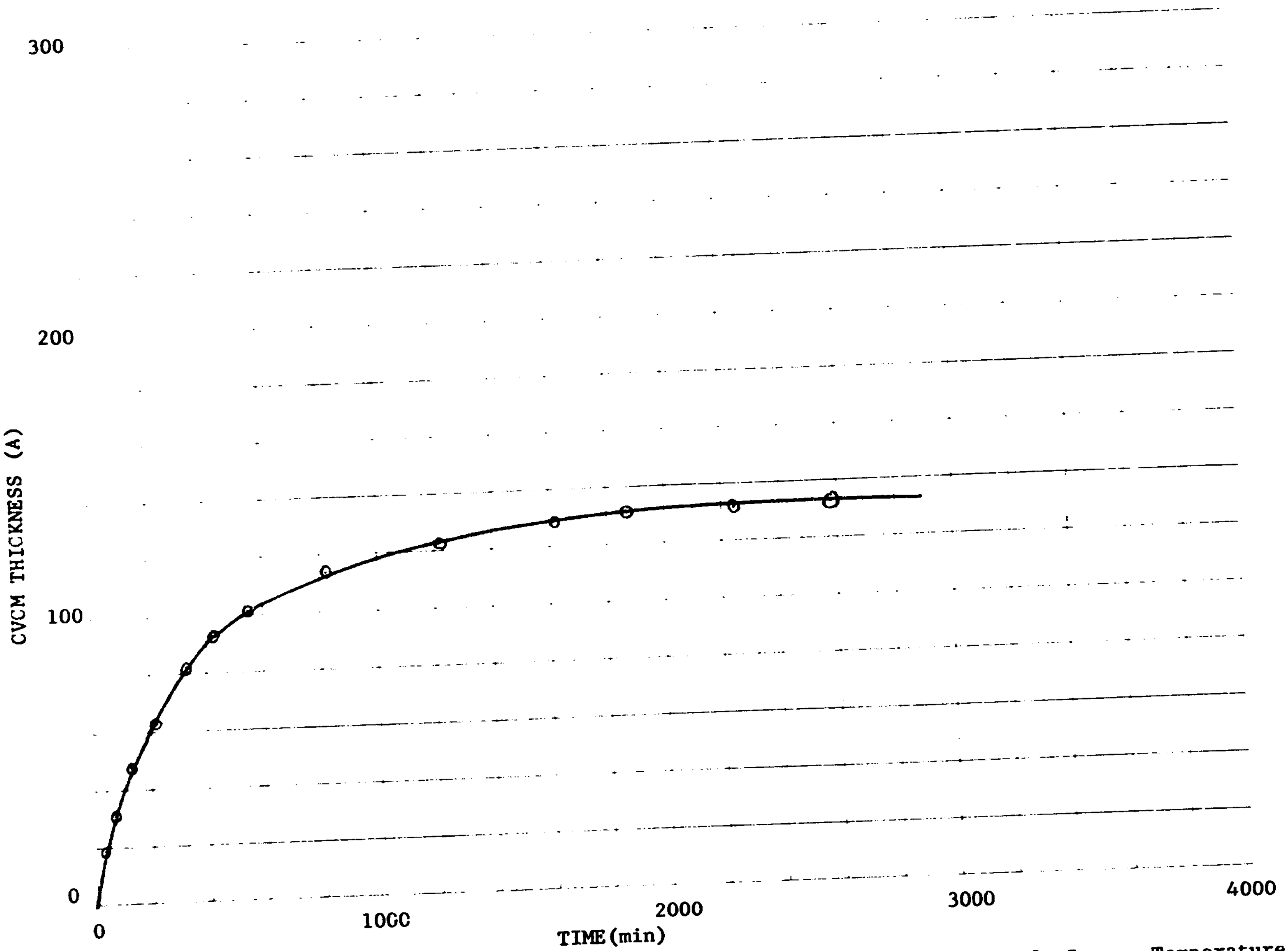

Figure CVCM Thickness In Angstroms, Source Material Scotch-Weld 2216, JPL#31-VOD-3, Source Temperature 56°C, TQCM Temperature -80°C, TQCM Sensitivity $1.56 \times 10^{-9} g.cm^{-2}.Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

3M-415 TAPE

JPL#141-VOD-1

WEIGHT: 0.2577 g

CURE: AS RECEIVED

SOURCE TEMPERATURE: 55°C

WINDOW TEMPERATURE: -82°C

TQCM TEMPERATURE: -79°C

COMMENTS: BACKGROUND CHAMBER TRANSMITTANCE LOSS APPROACHED CVCM TRANSMITTANCE FOR TIME GREATER THAN 1000 MIN AND EXCEEDED IT AT 2831 MIN MAKING THE PLOT IN FIG. 23 QUESTIONABLE

WARMED TO -40°C PRODUCED NO SIGNIFICANT INCREASE IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 1.20 @ 120 nm
T = 0.90 @ 300 nm

C-2

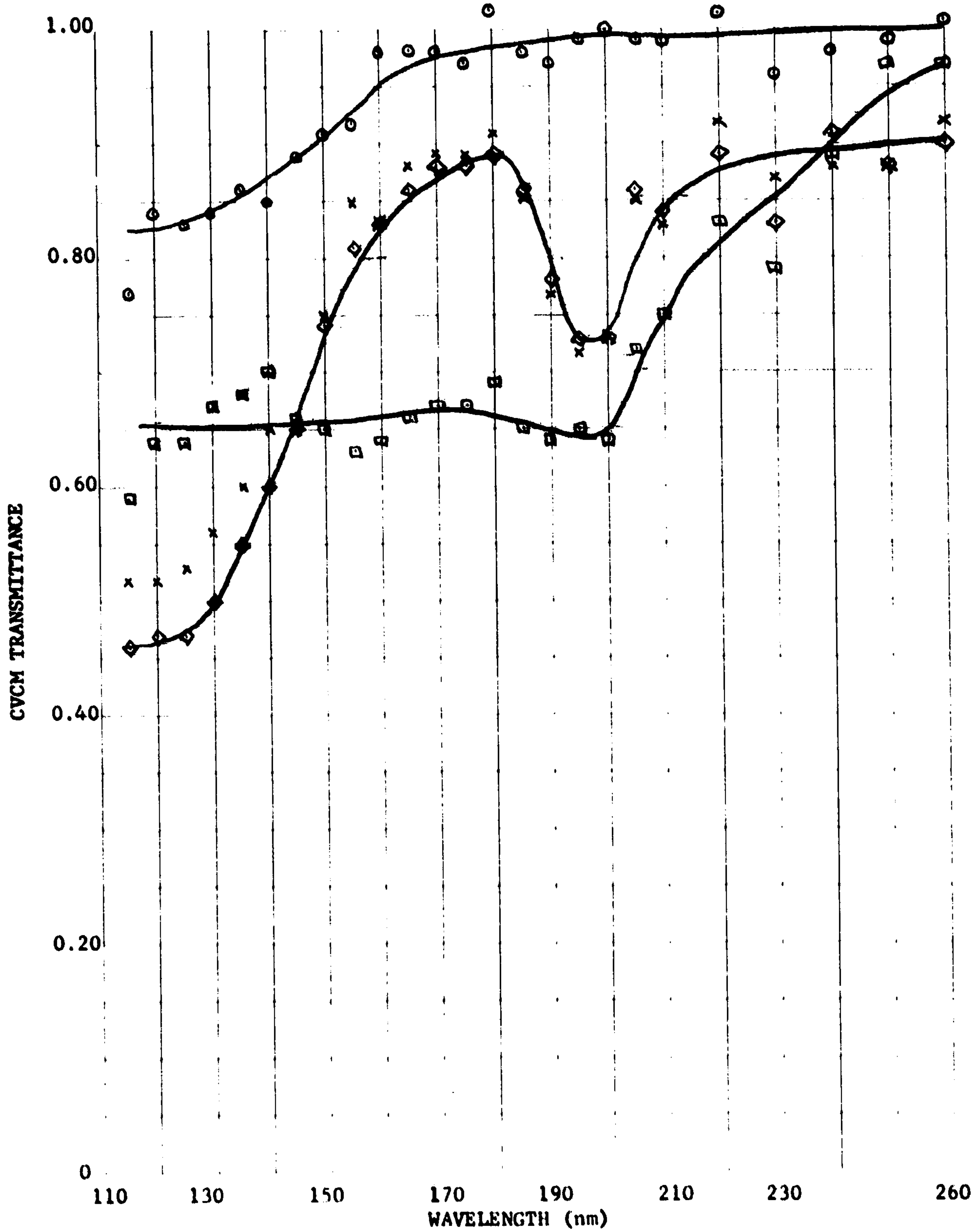

Figure 23. CVCM Transmittance Versus Wavelength, Source Material 3M-415, CVCM Thickness In Angstroms ⊙ 61, ⊡ 130, ◇ 237, × 261.

Table LI. CVCM Transmittance Versus Wavelength, Source Material SM-415, Source Temperature 55°C, MgF_2 Window Temperature -82°C, Chamber Pressure 5×10^{-6} Torr.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.74	0.77	0.51	0.59	0.23	0.46	0.17	0.52
120	0.81	0.84	0.56	0.64	0.24	0.47	0.17	0.52
125	0.80	0.83	0.56	0.64	0.24	0.47	0.18	0.53
130	0.81	0.84	0.59	0.67	0.27	0.50	0.21	0.56
135	0.83	0.86	0.60	0.68	0.33	0.55	0.25	0.60
140	0.82	0.85	0.62	0.70	0.38	0.60	0.30	0.65
145	0.87	0.89	0.61	0.66	0.47	0.65	0.37	0.65
150	0.89	0.91	0.60	0.65	0.56	0.74	0.47	0.75
155	0.90	0.92	0.58	0.63	0.63	0.81	0.57	0.85
160	0.98	0.98	0.62	0.64	0.73	0.83	0.69	0.83
165	0.98	0.98	0.64	0.66	0.76	0.86	0.73	0.87
170	0.98	0.98	0.65	0.67	0.78	0.88	0.75	0.89
175	0.97	0.97	0.65	0.67	0.78	0.88	0.75	0.89
180	1.02	1.02	0.67	0.69	0.79	0.89	0.77	0.91
185	0.98	0.98	0.63	0.65	0.76	0.86	0.71	0.85
190	0.97	0.97	0.62	0.64	0.68	0.78	0.63	0.77
195	0.99	0.99	0.63	0.65	0.63	0.73	0.58	0.72
200	1.00	1.00	0.62	0.64	0.63	0.73	0.59	0.73
205	0.99	0.99	0.70	0.72	0.76	0.86	0.71	0.85
210	0.99	0.99	0.75	0.75	0.79	0.84	0.70	0.78
220	1.02	1.02	0.83	0.83	0.84	0.89	0.84	0.92
230	0.96	0.96	0.79	0.79	0.78	0.83	0.79	0.87
240	0.99	0.98	0.89	0.89	0.86	0.91	0.80	0.88
250	0.99	0.99	0.97	0.97	0.88	0.88	0.88	0.88
260	1.01	1.01	0.97	0.97	0.90	0.90	0.92	0.92
270	1.01	1.01	0.97	0.97	0.90	0.90	0.92	0.92
280	0.99	0.99	0.96	0.96	0.89	0.89	0.90	0.90
290	0.99	0.99	0.96	0.96	0.88	0.88	0.88	0.88
300	1.02	1.02	0.99	0.99	0.92	0.92	0.93	0.93
CVCM THICKNESS (A)	61		130		237		261	
TIME AFTER 100% SCAN (min)	50		193		1389		2831	

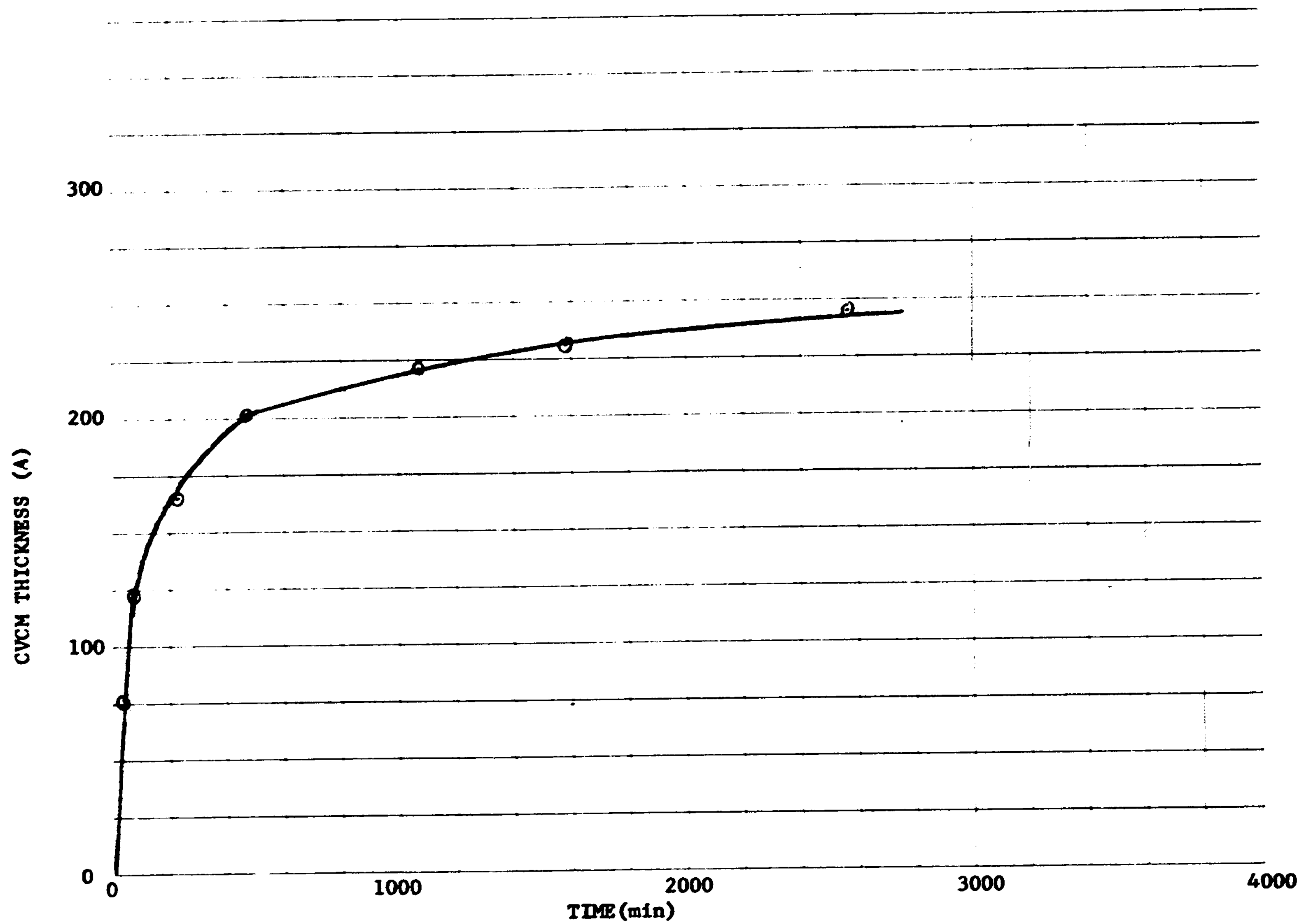

Figure 24. CVCM Thickness In Angstroms, Source Material Scotch Tape 3M-415, Source Temperature 55°C, TQCM Temperature -79°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assume To Be 1.0.

CHEMGLAZE Z-306 UNPRIMED

JPL#129B-VOD-1

WEIGHT: 0.1108 g

CURE: 24 HR @ AMBIENT; AMBIENT PRESSURE

SOURCE TEMPERATURE: 57°C

WINDOW TEMPERATURE: -85°C

TQCM TEMPERATURE: -83°C

COMMENTS: RELATIVE MINIMUM IN TRANSMITTANCE NEAR 195 nm
WARMED TO -40°C NO AFFECT ON TRANSITTANCE
AFTER TEST, AMBIENT TEMPERATURE T = 0.86 @ 120 nm
T = 0.93 @ 300 nm

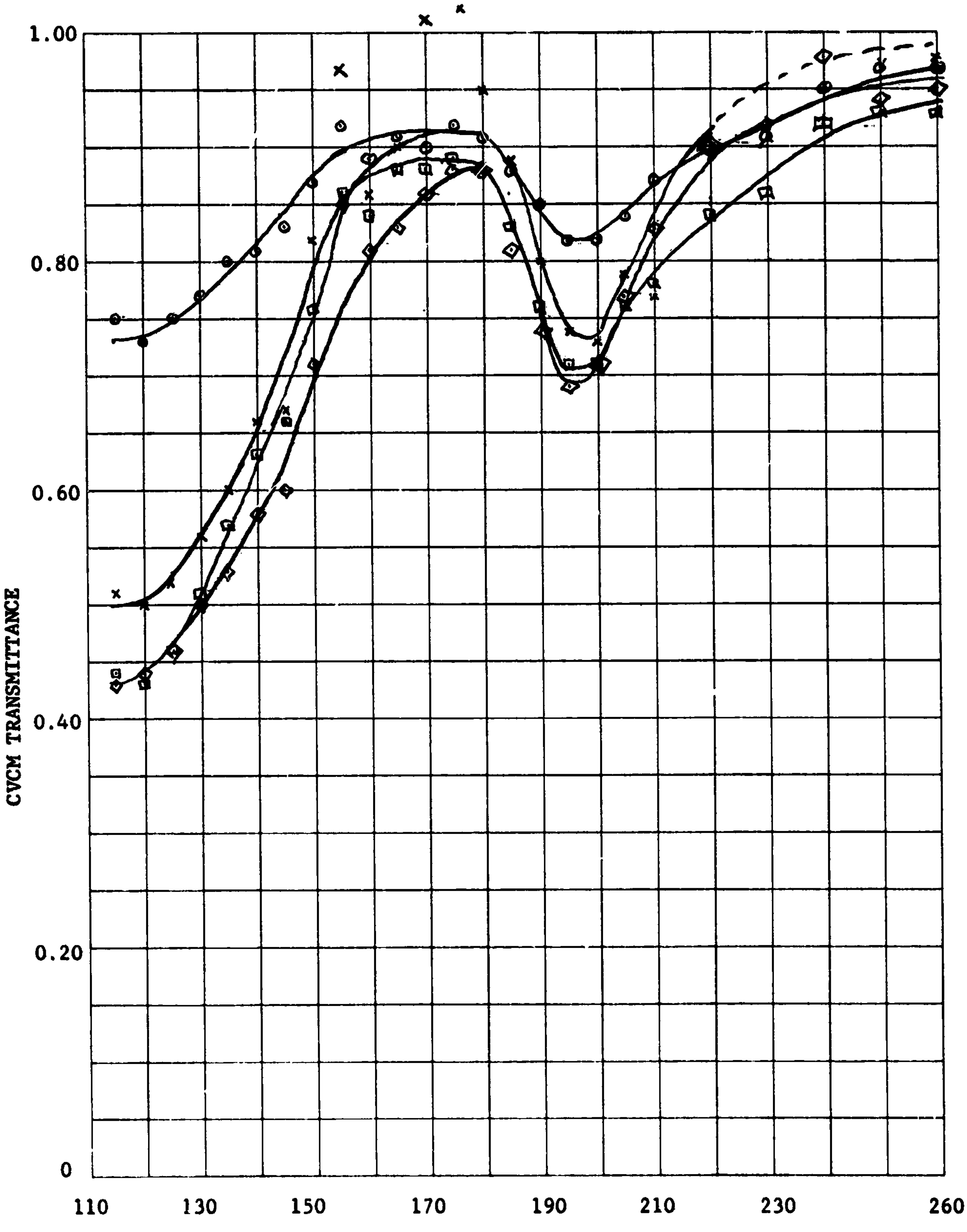

Figure 25. CVCM Transmittance Versus Wavelength, Source Material Chemglaze Z-306, JPL#129B-VOD-1, CVCM Thickness In Angstroms ⊙ 67, ◻ 158, ◇ 181, × 190.

Table LII. CVCM Transmittance Versus Wavelength, Source Material Chemglaze Z-306, JPL#1293-VOD-1, Source Temperature 57°C, MgF_2 Window Temperature -85°C, Chamber Pressure 5×10^{-6} Torr.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.69	0.75	0.23	0.44	0.11	0.43	0.09	0.51
120	0.67	0.73	0.22	0.43	0.12	0.44	0.08	0.50
125	0.69	0.75	0.25	0.46	0.14	0.46	0.10	0.52
130	0.71	0.77	0.30	0.51	0.18	0.50	0.14	0.56
135	0.74	0.80	0.36	0.57	0.21	0.53	0.18	0.60
140	0.75	0.81	0.42	0.63	0.26	0.58	0.24	0.66
145	0.79	0.83	0.51	0.66	0.34	0.60	0.31	0.67
150	0.83	0.87	0.61	0.76	0.45	0.71	0.46	0.82
155	0.88	0.92	0.71	0.86	0.59	0.85	0.61	0.97
160	0.88	0.89	0.75	0.84	0.68	0.81	0.68	0.86
165	0.90	0.91	0.79	0.88	0.70	0.83	0.72	0.90
170	0.89	0.90	0.79	0.88	0.73	0.86	0.84	1.02
175	0.91	0.92	0.80	0.89	0.75	0.88	0.85	1.03
180	0.90	0.91	0.79	0.88	0.75	0.88	0.77	0.95
185	0.87	0.88	0.74	0.83	0.68	0.81	0.71	0.89
190	0.84	0.85	0.67	0.76	0.61	0.74	0.62	0.80
195	0.81	0.82	0.62	0.71	0.56	0.69	0.56	0.74
200	0.81	0.82	0.62	0.71	0.58	0.71	0.55	0.73
205	0.83	0.84	0.67	0.76	0.64	0.77	0.61	0.79
210	0.87	0.87	0.75	0.78	0.75	0.83	0.67	0.77
220	0.90	0.90	0.81	0.84	0.82	0.90	0.97	1.07
230	0.91	0.91	0.83	0.86	0.84	0.92	0.95	1.05
240	0.95	0.95	0.89	0.92	0.90	0.98	1.00	1.10
250	0.97	0.97	0.93	0.93	0.94	0.94	1.04	1.04
260	0.97	0.97	0.93	0.93	0.95	0.95	0.98	0.98
270	0.97	0.97	0.95	0.95	0.95	0.95	0.95	0.95
280	0.97	0.97	0.95	0.95	0.96	0.96	0.99	0.99
290	0.97	0.97	0.94	0.94	0.95	0.95	0.96	0.96
300	0.98	0.98	0.95	0.95	0.97	0.97	0.98	0.98
CVCM THICKNESS (A)	6[illegible]		158		181		190	
TIME AFTER 100% SCAN (min)	118		1090		2533		3983	

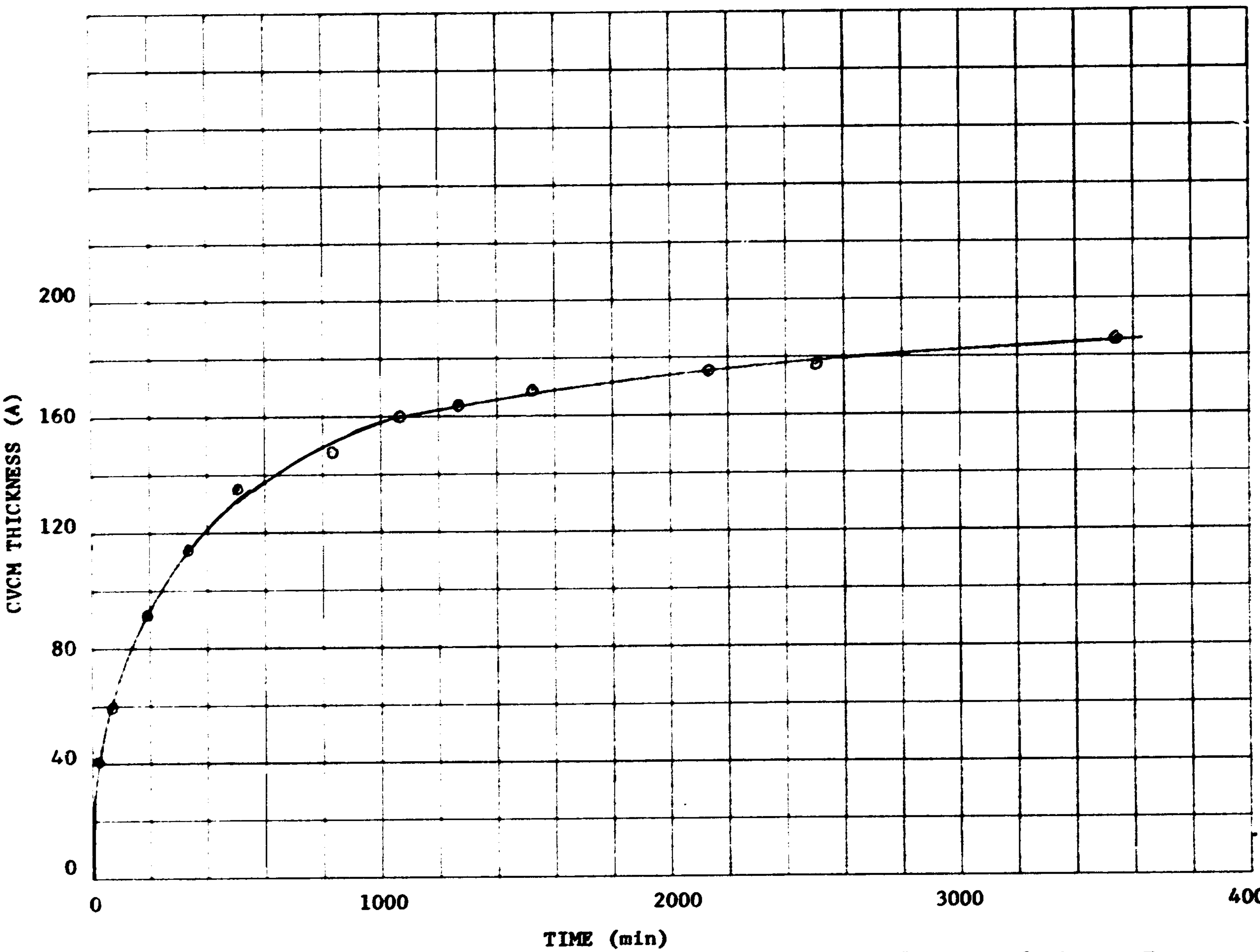

Figure 26. CVCM Thickness In Angstroms, Source Material Chemglaze Z-306, JPL#129B-VOD-1, Source Temperature TQCM Temperature -83°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To B

CHEMGLAZE Z-306 OVER CHEMGLAZE 9922 PRIMER

JPL#131-VOD-1

WEIGHT: 0.1636 g, PAINT THICKNESS (2 COATS) 0.0036 cm, PRIMER 0.0011 cm

CURE: 24 HR @ AMBIENT; AMBIENT PRESSURE

SOURCE TEMPERATURE: 55°C

WINDOW TEMPERATURE: -79°C

TQCM TEMPERATURE: -83°C

COMMENTS: RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm

WARMED TO -40°C, NO AFFECT ON TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE T = 1.02 @ 120 nm
T = 0.88 @ 300 nm

ONLY SLIGHT INCREASE IN DEPOSITION OVER THE UNPRIMED Z-306 DURING THE FIRST 4000 MIN

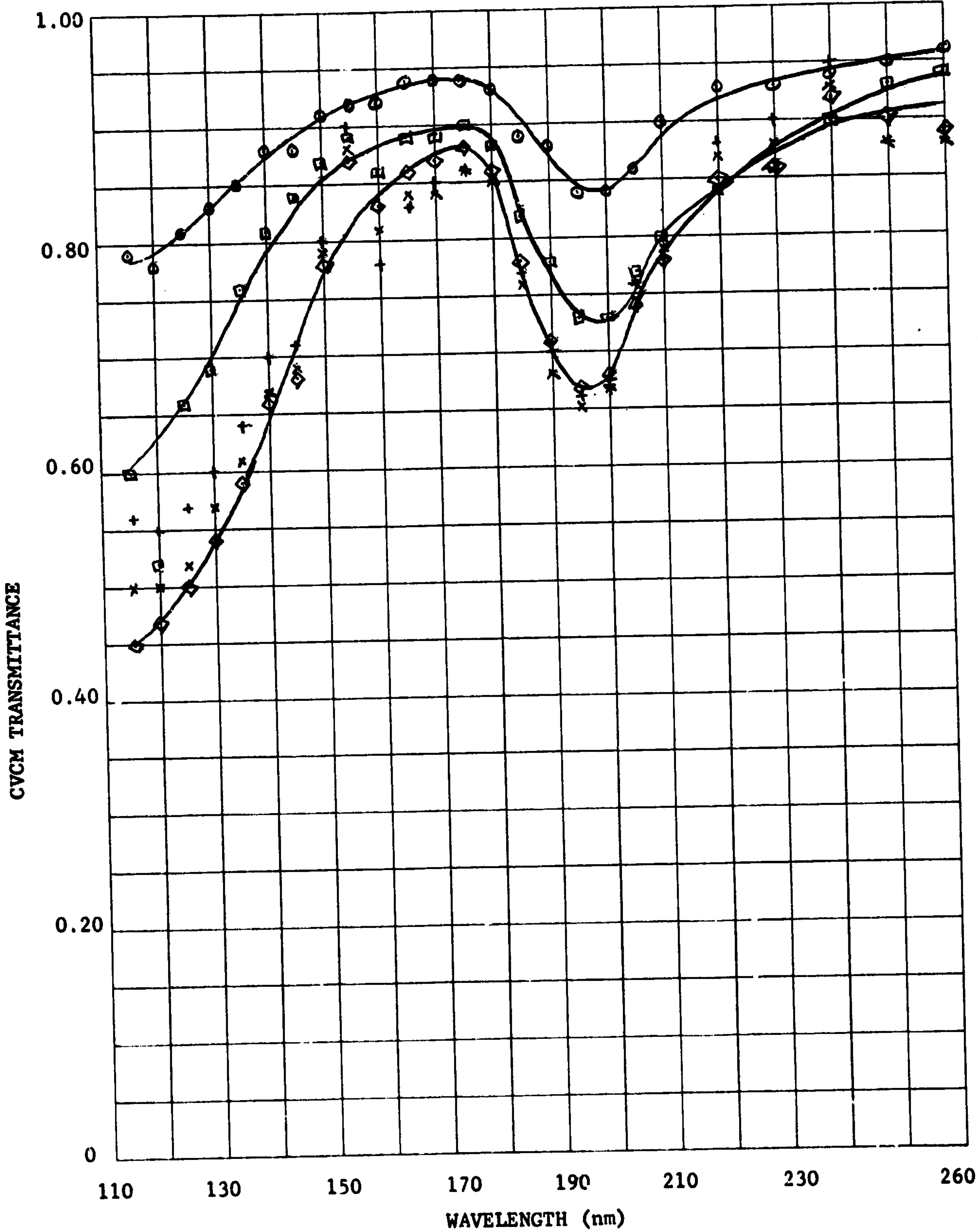

Figure 27. CVCM Transmittance Versus Wavelength, Source Material Chemglaze Z-306/9922, JPL#131-VOD-1, CVCM Thickness In Angstroms ⊙ 60, ◻ 118, ◇ 193, × 203, + 212.

Table LIII. CVCM Transmittance Versus Wavelength, Source Material Chemglaze Z-306 With 9922 Primer, JPL#131-VOD-1, Source Temperature 55°C, MgF_2 Window Temperature -79°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5
115	0.75	0.79	0.50	0.60	0.20	0.45	0.15	0.50	0.12	0.56
120	0.74	0.78	0.52	0.52	0.22	0.47	0.15	0.50	0.11	0.55
125	0.77	0.81	0.56	0.66	0.25	0.50	0.17	0.52	0.13	0.57
130	0.79	0.83	0.59	0.69	0.29	0.54	0.22	0.57	0.16	0.60
135	0.81	0.85	0.66	0.76	0.34	0.59	0.26	0.61	0.20	0.64
140	0.84	0.88	0.71	0.81	0.41	0.66	0.32	0.67	0.26	0.70
145	0.86	0.88	0.78	0.84	0.49	0.68	0.40	0.69	0.33	0.71
150	0.89	0.91	0.81	0.87	0.59	0.78	0.50	0.79	0.42	0.80
155	0.90	0.92	0.83	0.89	0.68	0.87	0.59	0.88	0.52	0.90
160	0.91	0.92	0.83	0.86	0.73	0.83	0.66	0.81	0.59	0.78
165	0.93	0.94	0.86	0.89	0.76	0.86	0.69	0.84	0.64	0.83
170	0.93	0.94	0.86	0.89	0.77	0.87	0.69	0.84	0.66	0.85
175	0.93	0.94	0.87	0.90	0.78	0.88	0.71	0.86	0.67	0.86
180	0.92	0.93	0.85	0.88	0.76	0.86	0.70	0.85	0.66	0.85
185	0.88	0.89	0.79	0.82	0.68	0.78	0.61	0.76	0.58	0.77
190	0.87	0.88	0.75	0.78	0.61	0.71	0.53	0.68	0.51	0.70
195	0.83	0.84	0.70	0.73	0.57	0.67	0.50	0.63	0.47	0.66
200	0.83	0.84	0.70	0.73	0.58	0.68	0.52	0.67	0.48	0.67
205	0.85	0.86	0.74	0.77	0.64	0.74	0.61	0.76	0.57	0.76
210	0.90	0.90	0.80	0.80	0.73	0.78	0.71	0.79	0.68	0.78
220	0.93	0.93	0.84	0.84	0.80	0.85	0.79	0.87	0.78	0.88
230	0.93	0.93	0.86	0.86	0.81	0.86	0.80	0.88	0.80	0.90
240	0.94	0.94	0.90	0.90	0.87	0.92	0.85	0.93	0.85	0.95
250	0.95	0.95	0.93	0.93	0.90	0.90	0.88	0.88	0.88	0.88
260	0.96	0.96	0.94	0.94	0.89	0.89	0.88	0.88	0.89	0.89
270	0.96	0.96	0.94	0.94	0.90	0.90	0.88	0.88	0.89	0.89
280	0.96	0.96	0.94	0.94	0.90	0.90	0.88	0.88	0.89	0.89
290	0.95	0.95	0.95	0.95	0.91	0.91	0.88	0.88	0.89	0.89
300	0.96	0.96	0.95	0.95	0.92	0.92	0.89	0.89	0.90	0.90
CVCM THICKNESS (A)	60		118		193		203		212	
TIME AFTER 100% SCAN (min)	72		227		1539		2870		4292	

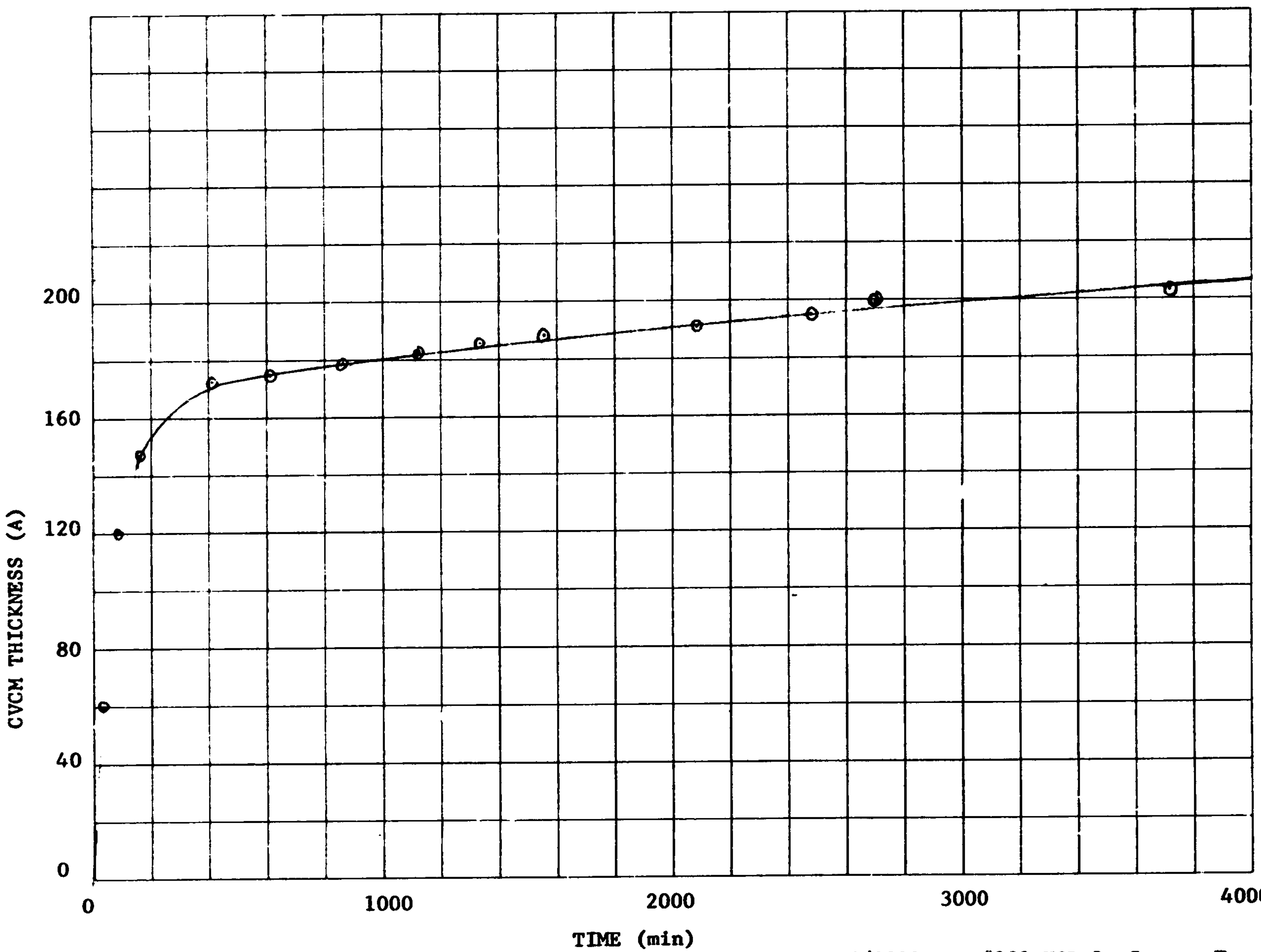

Figure 28. CVCM Thickness In Angstroms, Source Material Chemglaze Z-306/9922, JPL#131-VOD-1, Source Temper
55°C, TQCM Temperature -83°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assu
To Be 1.0.

CHEMGLAZE Z-306 OVER CHEMGLAZE 9922 PRIMER

JPL#131-VOD-2

WEIGHT: 0.1617 g

CURE: 24 HR @ AMBIENT; AMBIENT PRESSURE
24 HR @ 176°F; VACUUM

SOURCE TEMPERATURE: 55°C

WINDOW TEMPERATURE: -79°C

TQCM TEMPERATURE: -82°C

COMMENTS: AFTER TIME 382 MIN STOPPED TEST DUE TO LN_2 LEAKAGE INTO VACUUM CHAMBER

RECLEANED MgF_2 WINDOW AND ELEVATED SOURCE TO 98°C FOR THE REMAINDER OF THE TEST

RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm

RESTART OF TEST MAKES IT DIFFICULT TO COMPARE THE EFFECT OF THE VACUUM BAKE, HOWEVER A DEPOSITION OF ABOUT 300 A AT THE ELEVATED TEMPERATURE OF 98°C INDICATES THAT THE VACUUM BAKE IS EFFECTIVE IN REDUCING THE AMOUNT OF CVCM

AFTER TEST, AMBIENT TEMPERATURE T = 0.57 @ 120 nm
T = 0.98 @ 300 nm

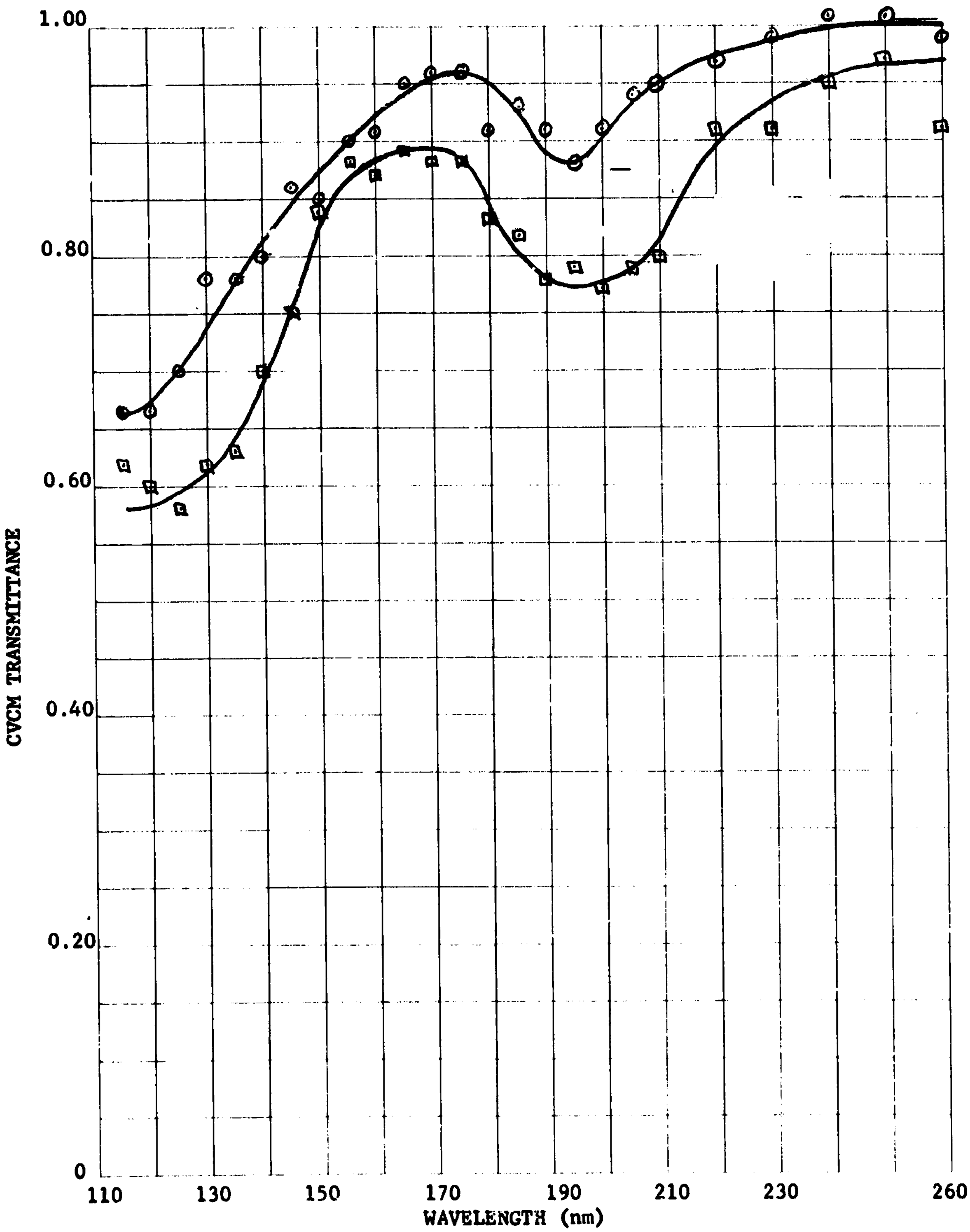

Figure 29. CVCM Transmittance Versus Wavelength, Source Material Z-306/9922, JPL#131-VOD-2, CVCM Thickness In Angstroms ⊙ 68, ⊡ 104.

Table LIV. CVCM Transmittance Versus Wavelength, Source Material Z-306/9922, JPL #131-VOD-2, Source Temperature 55°C, MgF_2 Window Temperature -79°C.

WAVELENGTH (nm)	T	T_1	T	T_2
115	0.61	0.67	0.50	0.62
120	0.61	0.67	0.48	0.60
125	0.64	0.70	0.46	0.58
130	0.72	0.78	0.50	0.62
135	0.72	0.78	0.51	0.63
140	0.74	0.80	0.58	0.70
145	0.83	0.86	0.67	0.75
150	0.82	0.85	0.76	0.84
155	0.87	0.90	0.80	0.88
160	0.90	0.91	0.82	0.87
165	0.94	0.95	0.84	0.89
170	0.95	0.96	0.83	0.88
175	0.95	0.96	0.83	0.88
180	0.90	0.91	0.78	0.83
185	0.92	0.93	0.77	0.82
190	0.90	0.91	0.73	0.78
195	0.87	0.88	0.74	0.79
200	0.90	0.91	0.72	0.77
205	0.93	0.94	0.74	0.79
210	0.95	0.95	0.80	0.80
220	0.97	0.97	0.91	0.91
230	0.99	0.99	0.91	0.91
240	1.01	1.01	0.95	0.95
250	1.01	1.01	0.97	0.97
260	0.99	0.99	0.91	0.91
270	0.98	0.98	0.93	0.93
280	0.97	0.97	0.91	0.91
290	1.00	1.00	0.92	0.92
300	1.03	1.03	0.92	0.92
CVCM THICKNESS (A)	68		104	
TIME AFTER 100% SCAN (min)	101		382	

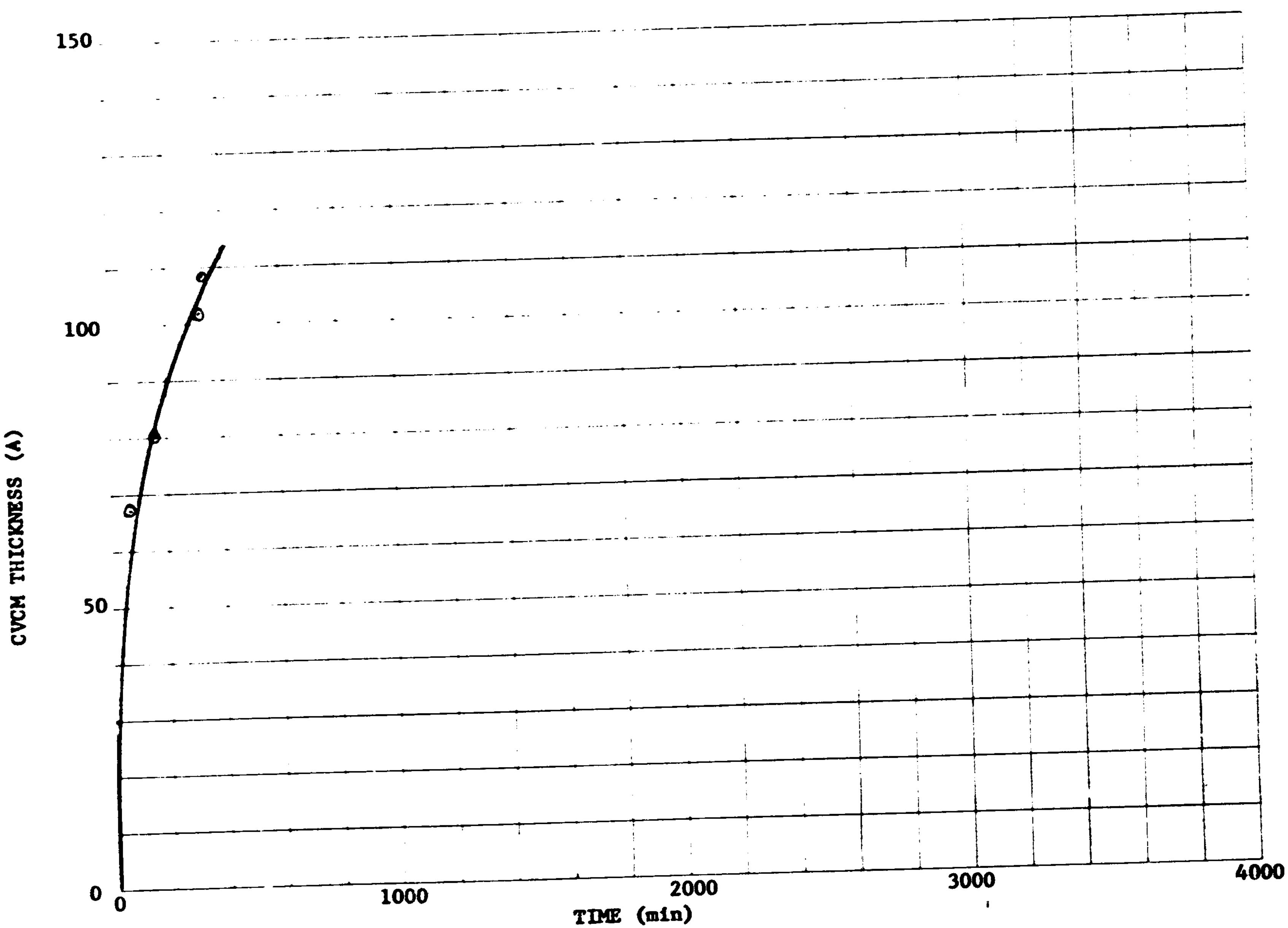

Figure 30. CVCM Thickness In Angstroms, Source Material Chemglaze Z-306/9922, JPL#131-VOD-2, Source Temperature 55°C, TQCM Temperature -82°C, TQCM Sensitivity $1.56 \times 10^{-9} g.cm^{-2}.Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

CHEMGLAZE Z-306 OVER CHEMGLAZE 9922 PRIMER

JPL#131-VOD-2

WEIGHT: 0.1617 g

CURE: 24 HR @ AMBIENT; AMBIENT PRESSURE
24 HR @ 176°F; VACUUM

SOURCE TEMPERATURE: 98°C

WINDOW TEMPERATURE: -73°C

TQCM TEMPERATURE: -82°C

COMMENTS: AFTER TIME 382 MIN STOPPED TEST DUE TO LN_2 LEAKAGE INTO VACUUM CHAMBER

RECLEANED MgF_2 WINDOW AND ELEVATED SOURCE TO 98°C FOR THE REMAINDER OF THE TEST

RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm

RESTART OF TEST MAKES IT DIFFICULT TO COMPARE THE EFFECT OF THE VACUUM BAKE, HOWEVER A DEPOSITION OF ABOUT 300 A AT THE ELEVATED TEMPERATURE OF 98°C INDICATES THAT THE VACUUM BAKE IS EFFECTIVE IN REDUCING THE AMOUNT OF CVCM

AFTER TEST, AMBIENT TEMPERATURE, T = 0.57 @ 120 nm
T = 0.98 @ 300 nm

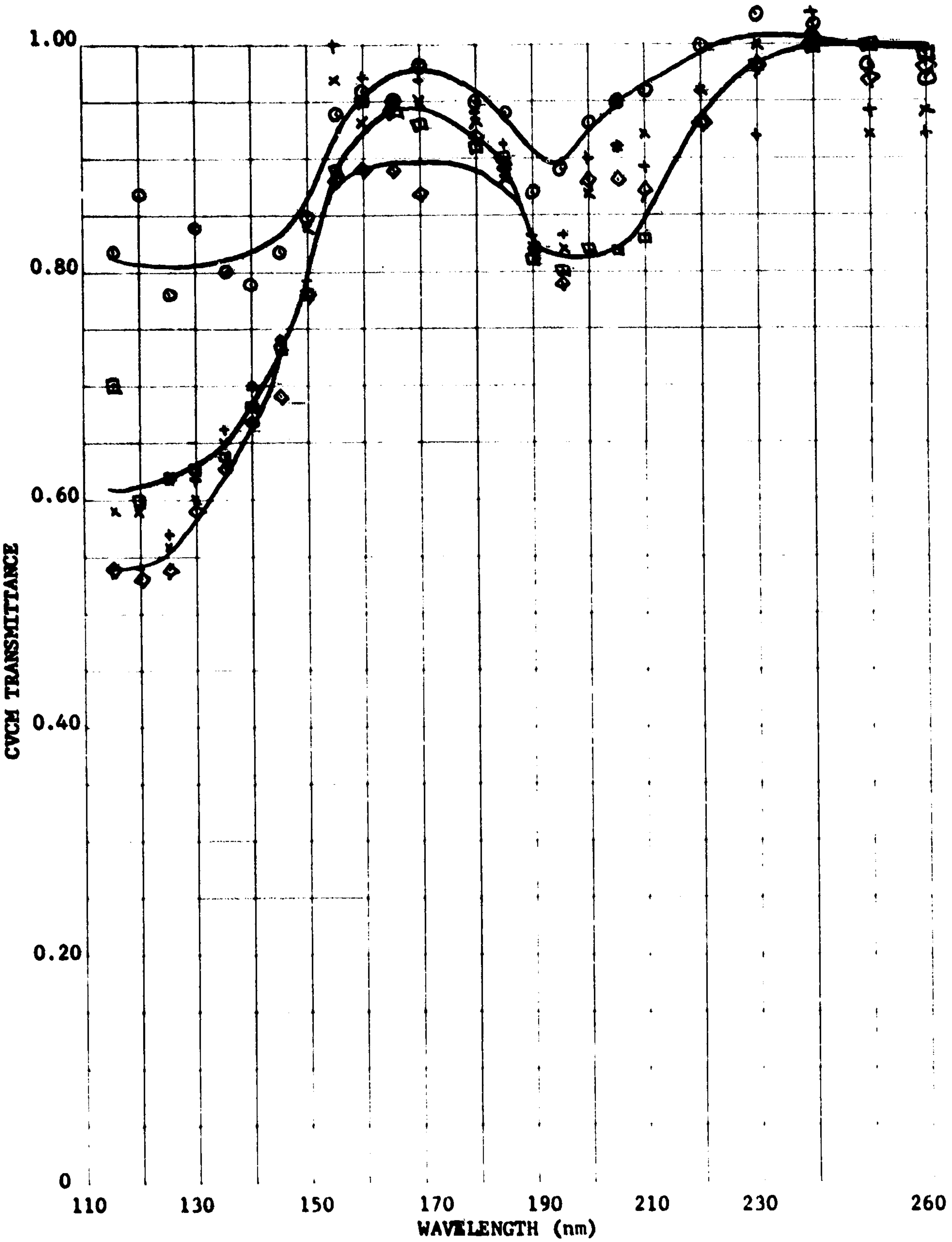

Figure 31. CVCM Transmittance Versus Wavelength, Source Material Z-306/9922, JPL#131-VOD-2, CVCM Thickness In Angstroms ⊙ 66, ⊡ 131, ◇ 181, × 208, + 226.

Table LV. CVCM Transmittance Versus Wavelength, Source Material Z-306/9922, JPL # 131-VOD-2, Source Temperature 98°C, MgF_2 Window Temperature -73°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5
115	0.78	0.82	0.62	0.70	0.31	0.54	0.25	0.59	0.10	0.54
120	0.73	0.87	0.52	0.60	0.30	0.53	0.25	0.59	0.10	0.54
125	0.74	0.78	0.54	0.62	0.31	0.54	0.22	0.56	0.13	0.57
130	0.80	0.84	0.55	0.63	0.36	0.59	0.26	0.60	0.18	0.62
135	0.76	0.80	0.56	0.64	0.40	0.63	0.31	0.65	0.22	0.66
140	0.75	0.79	0.60	0.68	0.44	0.67	0.36	0.70	0.26	0.70
145	0.80	0.82	0.68	0.73	0.52	0.69	0.46	0.74	0.36	0.74
150	0.83	0.85	0.73	0.78	0.61	0.78	0.56	0.84	0.46	0.84
155	0.92	0.94	0.84	0.89	0.71	0.88	0.69	0.97	0.62	1.00
160	0.95	0.96	0.93	0.95	0.79	0.89	0.79	0.93	0.78	0.97
165	0.94	0.95	0.92	0.94	0.79	0.89	0.81	0.95	0.76	0.95
170	0.97	0.98	0.91	0.93	0.77	0.87	0.81	0.95	0.78	0.97
180	0.94	0.95	0.89	0.91	0.82	0.92	0.79	0.93	0.75	0.94
185	0.93	0.94	0.88	0.90	0.79	0.89	0.74	0.88	0.72	0.91
190	0.86	0.87	0.79	0.81	0.72	0.82	0.68	0.82	0.64	0.83
195	0.88	0.89	0.78	0.80	0.69	0.79	0.68	0.82	0.64	0.83
200	0.92	0.93	0.80	0.82	0.78	0.88	0.73	0.87	0.71	0.90
205	0.94	0.95	0.80	0.82	0.78	0.88	0.77	0.91	0.72	0.91
210	0.96	0.96	0.83	0.83	0.82	0.87	0.84	0.92	0.79	0.89
220	1.00	1.00	0.93	0.93	0.88	0.93	0.88	0.96	0.86	0.96
230	1.03	1.03	0.98	0.98	0.93	0.98	0.92	1.00	0.92	0.92
240	1.02	1.02	1.00	1.00	0.96	1.01	0.92	1.00	0.93	1.03
250	0.98	0.98	1.00	1.00	0.97	0.97	0.92	0.92	0.94	0.94
260	0.97	0.97	0.99	0.99	0.98	0.98	0.94	0.94	0.92	0.92
270	1.03	1.03	0.96	0.96	0.97	0.97	0.97	0.97	0.95	0.95
280	1.05	1.05	0.98	0.98	0.99	0.99	0.93	0.93	0.96	0.96
290	1.06	1.06	1.01	1.01	1.00	1.00	0.95	0.95	0.99	0.99
300	1.02	1.02	1.03	1.03	1.00	1.00	0.96	0.96	0.98	0.98
CVCM THICKNESS (Å)	66		131		181		208		226	
TIME AFTER 100% SCAN (min)	64		171		1356		2755		4244	

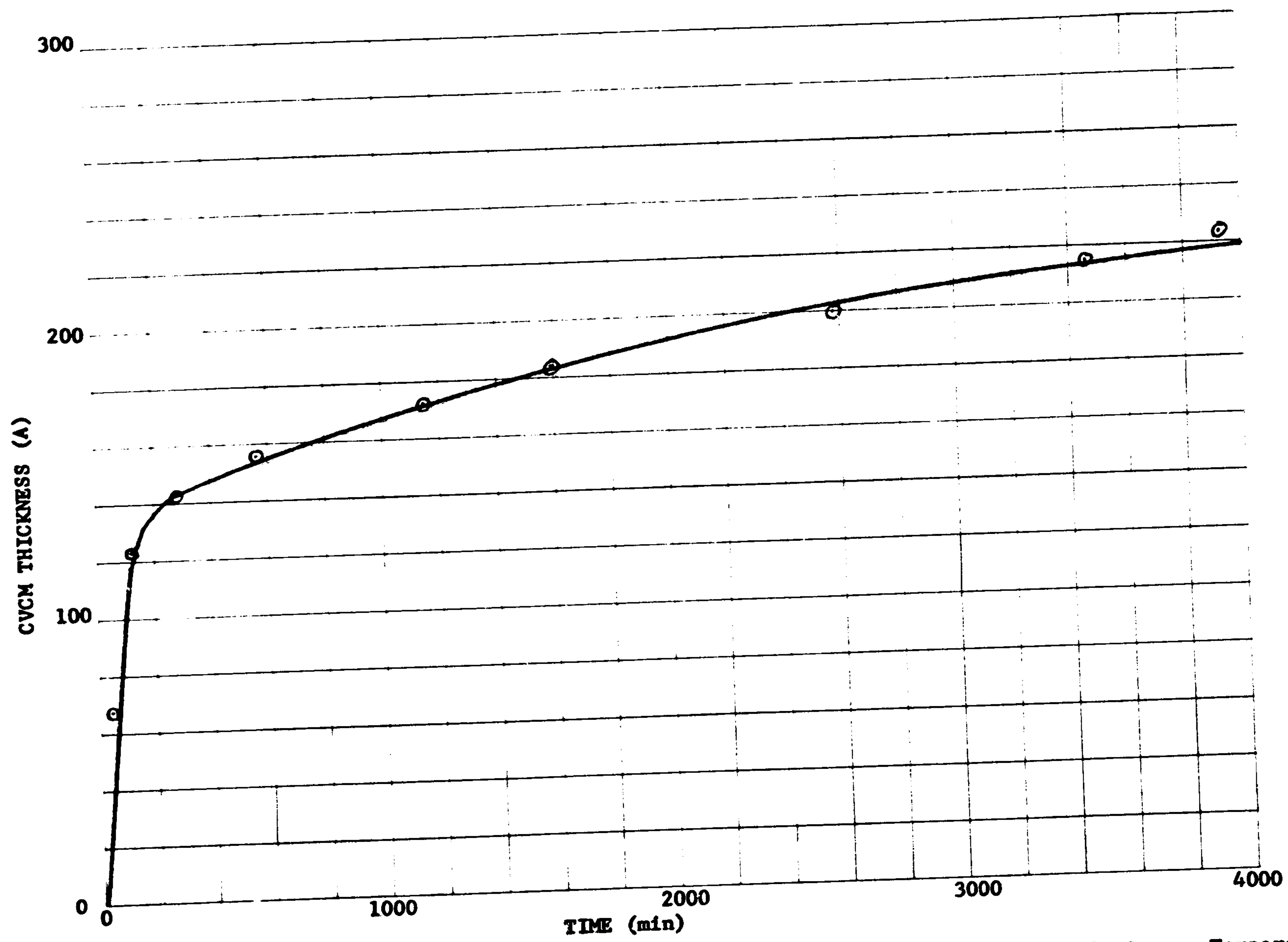

Figure 32. CVCM Thickness In Angstroms, Source Material Chemglaze Z-306/9922, JPL#131-VOD-2, Source Temperature 98°C, TQCM Temperature -82°C, TQCM Sensitivity $1.56 \times 10^{-9} g.cm^{-2}.Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

CHEMGLAZE Z-306 OVER CHEMLOCK AP-131 PRIMER

JPL#129C-VOD-1

WEIGHT: 0.0935 g, PAINT THICKNESS (2 COATS) 0.0023 cm, PRIMER 0.00025 cm

CURE: 24 HR @ AMBIENT; AMBIENT PRESSURE

SOURCE TEMPERATURE: 53°C

WINDOW TEMPERATURE: -80°C

TQCM TEMPERATURE: -82°C

COMMENTS: LARGE RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm

SLIGHTLY LARGER DEPOSITION THAN UNBAKED Z-306/9922 ALTHOUGH SOURCE WEIGHT ABOUT HALF THAT OF Z-306/9922

AFTER TEST, AMBIENT TEMPERATURE T = 0.90 @ 120 nm
T = 0.96 @ 300 nm

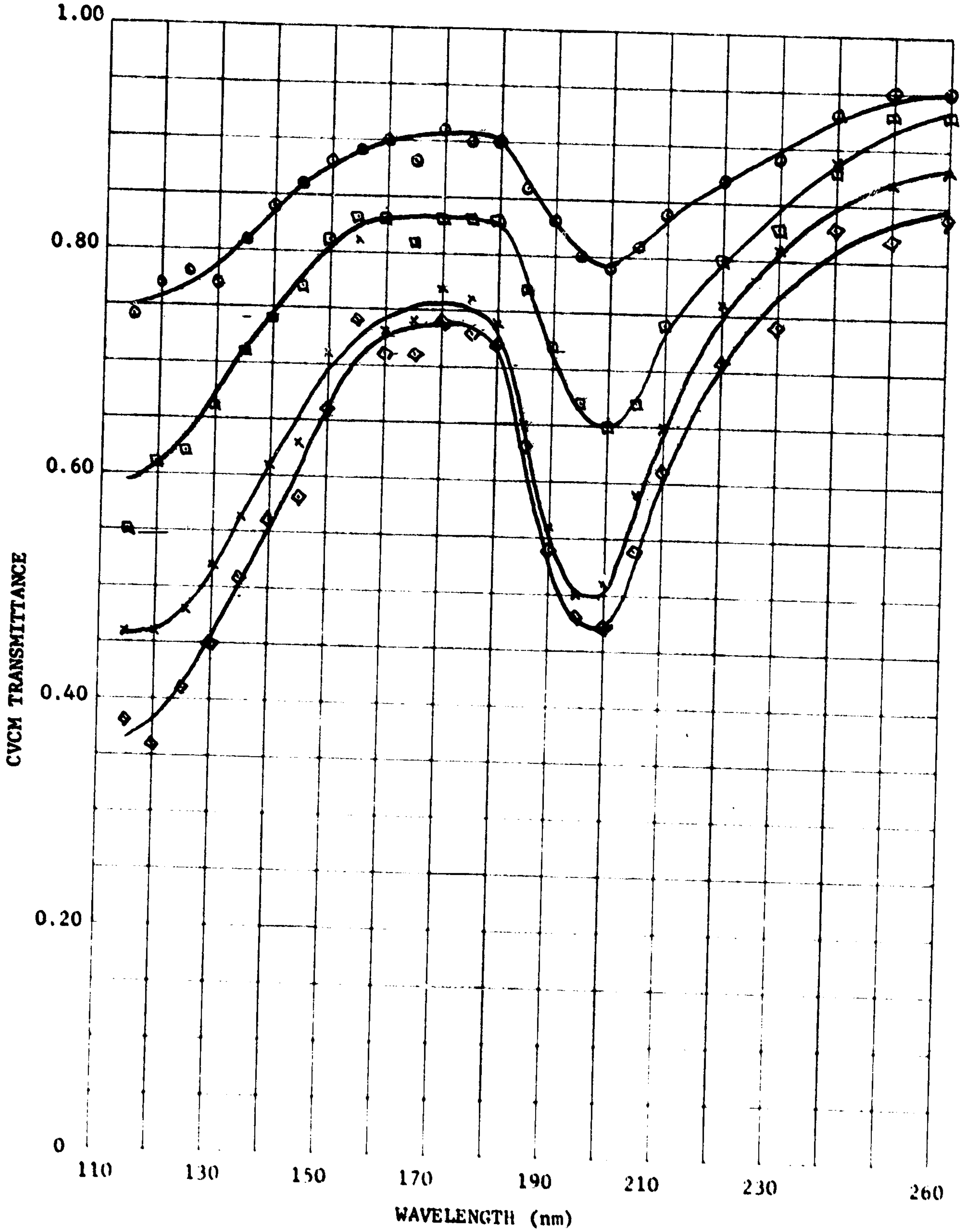

Figure 33. CVCM Transmittance Versus Wavelength, Source Material Chemglaze Z-306/AP-131, JPL#129C-VOD-1, CVCM Thickness In Angstroms ○ 64, ◘ 130, ◇ 297, × 311.

Table LVI. CVCM Transmittance Versus Wavelength, Source Material Chemglaze Z-306 With AP-131 Primer, JPL#129C-VOD-1, Source Temperature 53°C, MgF_2 Window Temperature -80°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.71	0.74	0.49	0.55	0.14	0.38	0.11	0.46
120	0.74	0.77	0.55	0.61	0.12	0.36	0.11	0.46
125	0.75	0.78	0.56	0.62	0.17	0.41	0.13	0.48
130	0.74	0.77	0.60	0.66	0.21	0.45	0.17	0.52
135	0.78	0.81	0.65	0.71	0.27	0.51	0.21	0.56
140	0.81	0.84	0.68	0.74	0.32	0.56	0.26	0.61
145	0.84	0.86	0.73	0.77	0.40	0.58	0.34	0.63
150	0.86	0.88	0.77	0.81	0.48	0.66	0.42	0.71
155	0.87	0.89	0.79	0.83	0.56	0.74	0.52	0.81
160	0.89	0.90	0.82	0.83	0.61	0.71	0.58	0.73
165	0.87	0.88	0.80	0.81	0.61	0.71	0.59	0.74
170	0.90	0.91	0.82	0.83	0.64	0.74	0.62	0.77
175	0.89	0.90	0.82	0.83	0.63	0.73	0.61	0.76
180	0.89	0.90	0.82	0.83	0.62	0.72	0.59	0.74
185	0.85	0.86	0.76	0.77	0.53	0.63	0.50	0.65
190	0.82	0.83	0.71	0.72	0.44	0.54	0.41	0.56
195	0.79	0.80	0.66	0.67	0.38	0.48	0.35	0.50
200	0.78	0.79	0.64	0.65	0.37	0.47	0.36	0.51
205	0.80	0.81	0.66	0.67	0.44	0.54	0.44	0.59
210	0.84	0.84	0.74	0.74	0.56	0.61	0.57	0.65
220	0.87	0.87	0.80	0.80	0.66	0.71	0.68	0.76
230	0.89	0.89	0.83	0.83	0.69	0.74	0.73	0.81
240	0.93	0.93	0.88	0.88	0.78	0.83	0.81	0.89
250	0.95	0.95	0.93	0.93	0.82	0.82	0.87	0.87
260	0.95	0.95	0.93	0.93	0.84	0.84	0.88	0.88
270	0.97	0.97	0.94	0.94	0.87	0.87	0.90	0.90
280	0.97	0.97	0.97	0.97	0.87	0.87	0.90	0.90
290	0.98	0.98	0.99	0.99	0.88	0.88	0.91	0.91
300	0.98	0.98	0.99	0.99	0.90	0.90	0.91	0.91
CVCM THICKNESS (Å)	64		130		297		311	
TIME AFTER 100% SCAN (min)	53		124		1424		2859	

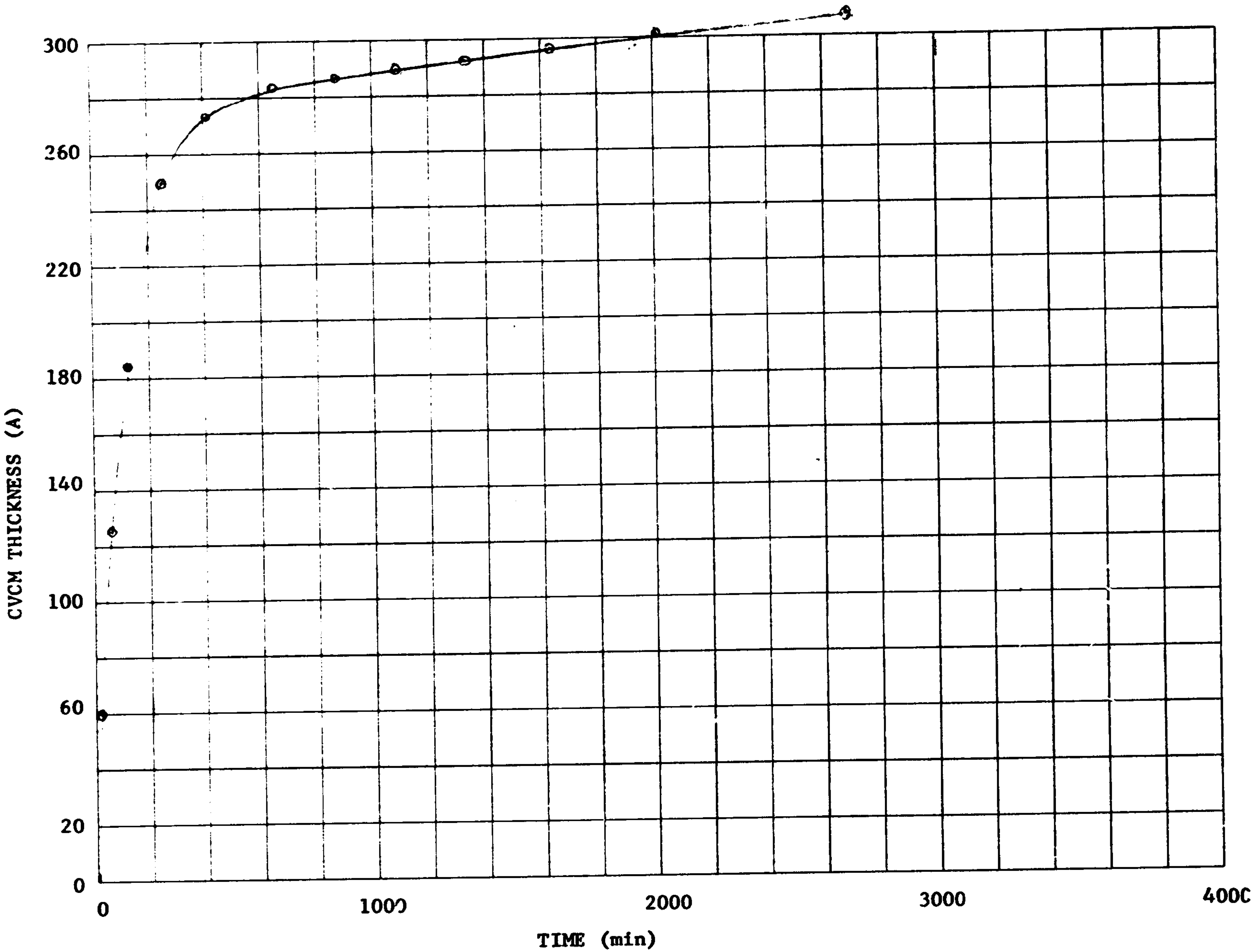

Figure 34. CVCM Thickness In Angstroms, Source Material Chemglaze Z-306/AP-131, JPL#129C-YOD-1, Source Temperature 53°C, TQCM Temperature -82°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

CHEMGLAZE Z-306 OVER CHEMLOCK AP-131 PRIMER

JPL#129C-VOD-2

WEIGHT: 0.0902 g

CURE: 24 HR @ AMBIENT; AMBIENT PRESSURE
24 HR @ 176°F; VACUUM

SOURCE TEMPERATURE: 59°C

WINDOW TEMPERATURE: -79°C

TQCM TEMPERATURE: -38°C

COMMENTS: MALFUNCTION IN TQCM TEMPERATURE CONTROL MAKES IT DIFFICULT TO COMPARE EFFECTIVENESS OF VACUUM BAKE, HOWEVER HIGH TRANSMITTANCE VALUES INDICATES THAT CVCM WAS STAYING ON THE SURFACE OF THE TQCM AT -38°C AND THUS THE VACUUM BAKE AT 176°F REDUCED THE DEPOSITION BY A FACTOR OF 10

RELATIVE MINIMUM IN TRANSMITTANCE NEAR 195 nm

WARMED TO -40°C, NO AFFECT ON TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE T = 0.85 @ 120 nm
T = 0.91 @ 300 nm

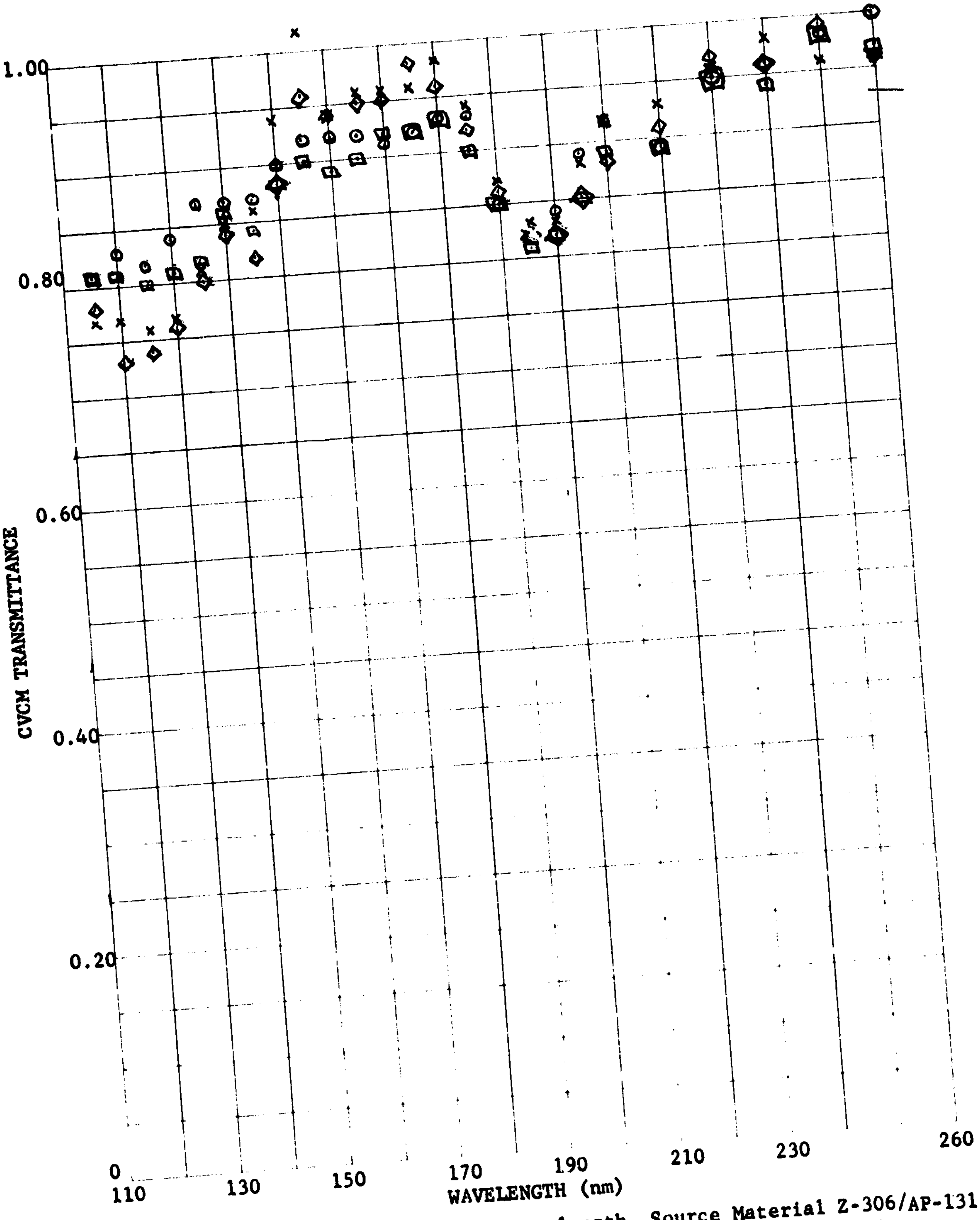

Figure 35. CVCM Transmittance Versus Wavelength, Source Material Z-306/AP-131, JPL# 129C-VOD-2, CVCM Thickness In Angstroms ⊙ 31, ⊡ 40, ◇ 35, × 33.

Table LVII. CVCM Transmittance Versus Wavelength, Source Material Z-306/AP-131, JPL #129C-VOD-2, Source Temperature 59°C, MgF_2 Window Temperature -79°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.75	0.81	0.70	0.81	0.58	0.78	0.45	0.77
120	0.77	0.83	0.70	0.81	0.53	0.73	0.45	0.77
125	0.76	0.82	0.69	0.80	0.54	0.74	0.44	0.76
130	0.78	0.84	0.70	0.81	0.56	0.76	0.45	0.77
135	0.81	0.87	0.71	0.82	0.60	0.80	0.49	0.81
140	0.81	0.87	0.75	0.86	0.64	0.84	0.53	0.85
145	0.84	0.87	0.77	0.84	0.67	0.82	0.60	0.86
150	0.87	0.90	0.81	0.88	0.73	0.88	0.68	0.94
155	0.89	0.92	0.83	0.90	0.81	0.96	0.76	1.02
160	0.91	0.92	0.86	0.89	0.86	0.94	0.81	0.94
165	0.91	0.92	0.87	0.90	0.87	0.95	0.83	0.96
170	0.90	0.91	0.89	0.92	0.87	0.95	0.83	0.96
175	0.91	0.92	0.89	0.92	0.90	0.98	0.83	0.96
180	0.92	0.93	0.90	0.93	0.88	0.96	0.85	0.98
185	0.92	0.93	0.87	0.90	0.84	0.92	0.81	0.94
190	0.84	0.85	0.82	0.85	0.78	0.86	0.74	0.87
195	0.81	0.82	0.78	0.81	0.74	0.82	0.70	0.83
200	0.83	0.84	0.79	0.82	0.74	0.82	0.70	0.83
205	0.88	0.89	0.82	0.85	0.77	0.85	0.75	0.88
210	0.92	0.92	0.89	0.89	0.85	0.88	0.85	0.92
220	0.89	0.89	0.89	0.89	0.88	0.91	0.86	0.93
230	0.95	0.95	0.95	0.95	0.94	0.97	0.89	0.96
240	0.96	0.96	0.94	0.94	0.93	0.96	0.91	0.98
250	0.98	0.98	0.98	0.98	0.99	0.99	0.96	0.96
260	1.00	1.00	0.97	0.97	0.96	0.96	0.96	0.96
270	1.00	1.00	0.96	0.96	1.00	1.00	0.97	0.97
280	0.99	0.99	0.95	0.95	0.98	0.98	0.95	0.95
290	0.98	0.98	0.97	0.97	0.98	0.98	0.95	0.95
300	0.99	0.99	0.97	0.97	0.99	0.99	0.97	0.97
CVCM THICKNESS (A)	31		40		35		33	
TIME AFTER 100% SCAN (min)	115		300		1010		2490	

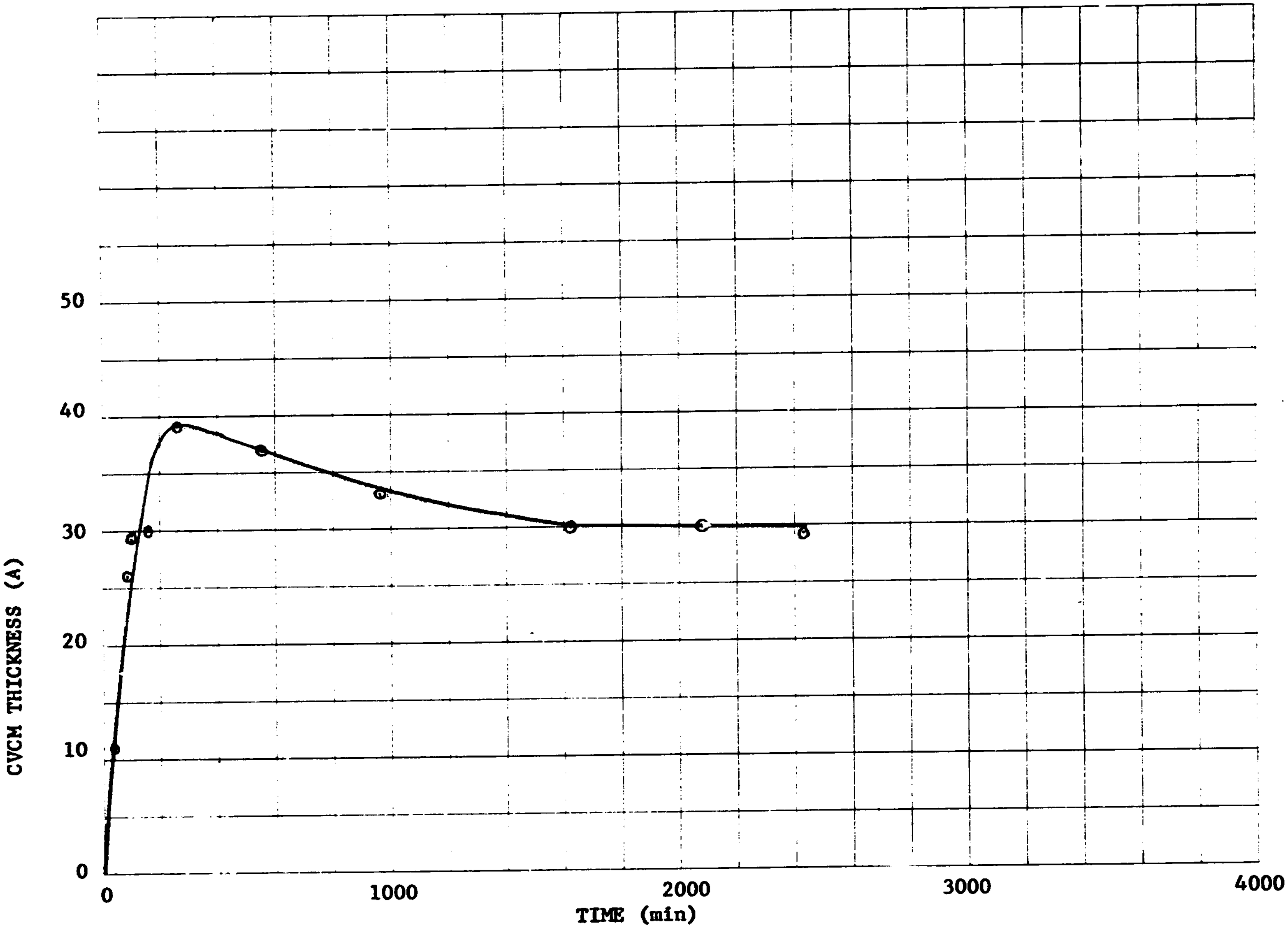

Figure 36. CVCM Thickness In Angstroms Versus Time, Source Material Z-306/AP-131, JPL#129C-VOD-2, Source Temperature 59°C, TQCM Temperature -38°C, TQCM Sensitivity $1.56 \times 10^{-9} g.cm^{-2}.Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

CAT-A-LAC 463-3-8 UNPRIMED

JPL#127-VOD-1

WEIGHT: 0.1456 g; THICKNESS (2 COATS) 0.00610 cm

CURE: 16 HR @ AMBIENT; AMBIENT PRESSURE

SOURCE TEMPERATURE: 54°C

WINDOW TEMPERATURE: -82°C

TQCM TEMPERATURE: -82°C

COMMENTS: RELATIVELY LOW OUTGASSING MATERIAL

WARMED TO -22°C, SLIGHT INCREASE (5%) IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 1.03 @ 120 nm

T = 0.90 @ 300 nm

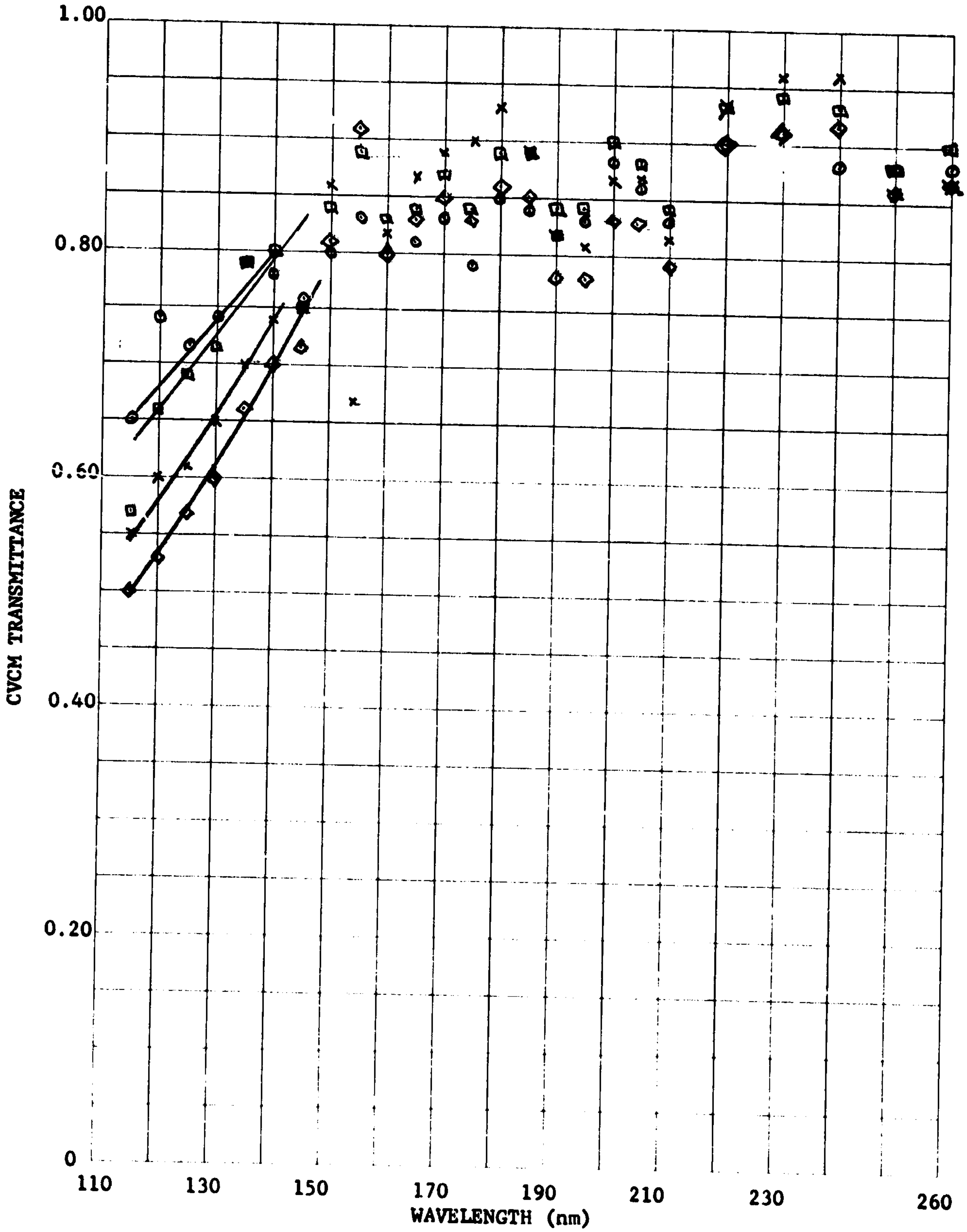

Figure 37. CVCM Transmittance Versus Wavelength, Source Material CAT-A-LAC 463-6-8, JPL#127-VOD-1, CVCM Thickness In Angstroms ⊘ 28, ⊡ 35, ◇ 45, × 50.

Table LVIII. CVCM Transmittance Versus Wavelength, Source Material CAT-A-LAC 463-6-8, JPL#127-VOD-1, Source Temperature 54°C, MgF_2 Window Temperature -82°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.57	0.65	0.34	0.57	0.16	0.50	0.11	0.55
120	0.66	0.74	0.43	0.66	0.19	0.53	0.16	0.60
125	0.64	0.72	0.46	0.69	0.23	0.57	0.17	0.61
130	0.66	0.74	0.49	0.72	0.26	0.60	0.21	0.65
135	0.71	0.79	0.56	0.79	0.32	0.66	0.26	0.70
140	0.70	0.78	0.57	0.80	0.36	0.70	0.30	0.74
145	0.71	0.76	0.58	0.75	0.44	0.72	0.37	0.75
150	0.75	0.80	0.67	0.84	0.53	0.81	0.48	0.86
155	0.78	0.83	0.72	0.89	0.63	0.91	0.59	0.67
160	0.78	0.80	0.73	0.83	0.66	0.80	0.63	0.82
165	0.79	0.81	0.74	0.84	0.69	0.83	0.68	0.87
170	0.81	0.83	0.77	0.87	0.71	0.85	0.70	0.89
175	0.77	0.79	0.74	0.84	0.69	0.83	0.71	0.90
180	0.83	0.85	0.79	0.89	0.72	0.86	0.74	0.93
185	0.82	0.84	0.79	0.89	0.71	0.85	0.70	0.89
190	0.80	0.82	0.74	0.84	0.64	0.78	0.63	0.82
195	0.81	0.83	0.74	0.84	0.64	0.78	0.62	0.81
200	0.86	0.88	0.80	0.90	0.69	0.83	0.68	0.87
205	0.84	0.86	0.78	0.88	0.69	0.83	0.68	0.87
210	0.83	0.83	0.79	0.84	0.71	0.79	0.72	0.82
220	0.90	0.90	0.88	0.93	0.82	0.90	0.83	0.93
230	0.91	0.91	0.89	0.94	0.83	0.91	0.86	0.96
240	0.88	0.88	0.88	0.93	0.84	0.92	0.86	0.96
250	0.88	0.88	0.88	0.88	0.86	0.86	0.86	0.86
260	0.88	0.88	0.90	0.90	0.87	0.87	0.87	0.87
270	0.90	0.90	0.90	0.90	0.89	0.89	0.88	0.88
280	0.84	0.84	0.85	0.85	0.83	0.83	0.83	0.83
290	0.92	0.92	0.93	0.93	0.91	0.91	0.91	0.91
300	0.78	0.78	0.79	0.79	0.77	0.77	0.79	0.79
CVCM THICKNESS (A)	28		35		45		50	
TIME AFTER 100% SCAN (min)	164		1347		2766		4226	

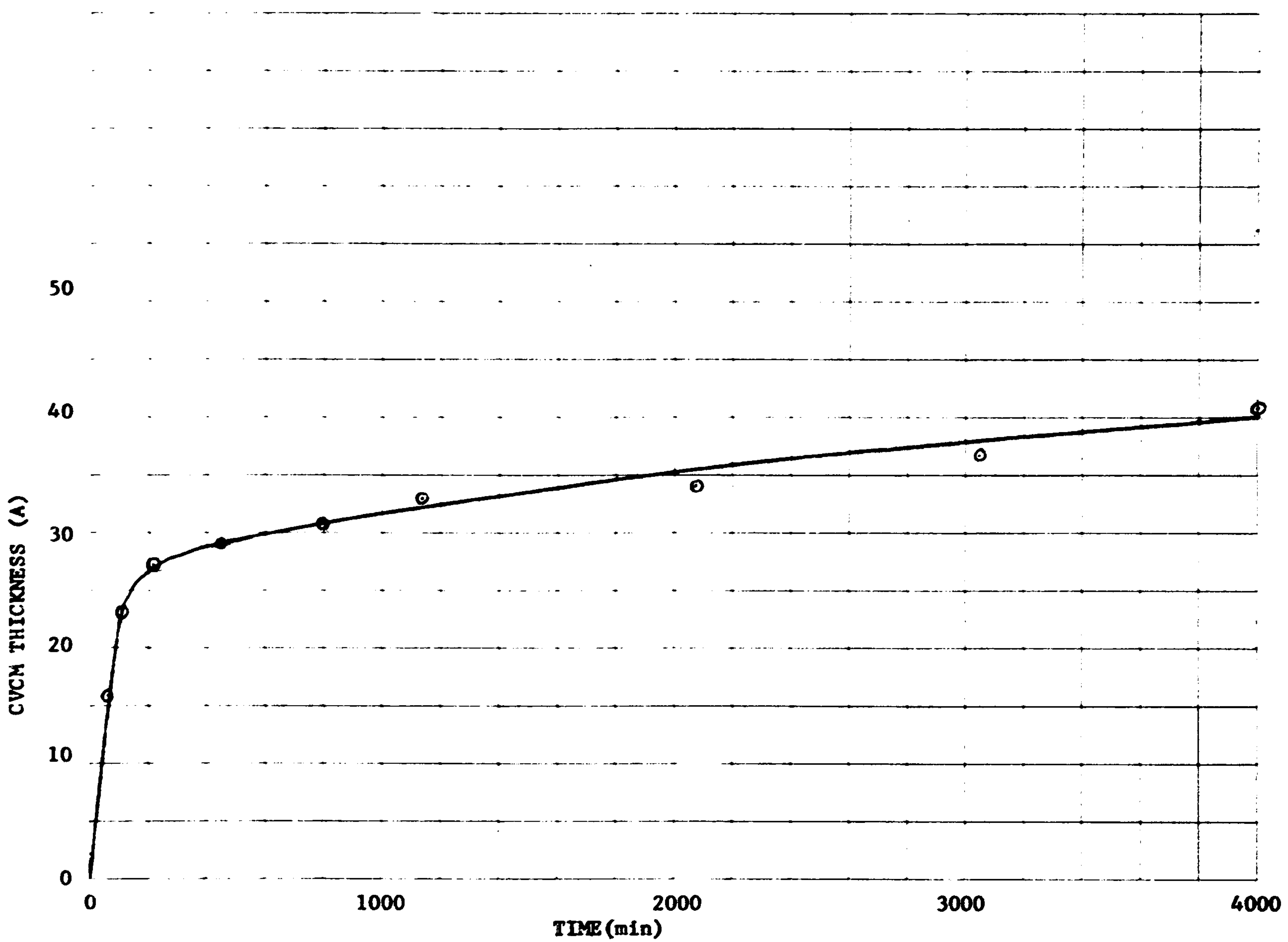

Figure 38. CVCM Thickness In Angstroms, Source Material Cat-A-Lac 463-6-8, JPL#127-VOD-1, Source Temperature 54°C, TOCM Temperature -82°C, TOCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

CAT-A-LAC 463-3-8 UNPRIMED

JPL#127-VOD-2

WEIGHT: 0.1713 g

CURE: 16 HR @ AMBIENT; AMBIENT PRESSURE
24 HR @ 176°F; VACUUM

SOURCE TEMPERATURE: 55°C

WINDOW TEMPERATURE: -81°C

TQCM TEMPERATURE: -76°C

COMMENTS: RELATIVELY LOW OUTGASSING MATERIAL

AT TIME 2865 MIN BACKGROUND TRANSMITTANCE ABOUT THE THE SAME AS CVCM TRANSMITTANCE

WARMED TO -40°C, NO SIGNIFICANT INCREASE IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 0.90 @ 120 nm
T = 0.82 @ 300 nm

VACUUM BAKE DECREASED CVCM DEPOSITION BY A FACTOR OF 2 ALTHOUGH THE SOURCE WEIGHT WAS 18% HIGHER THAN THE AMBIENT CURE

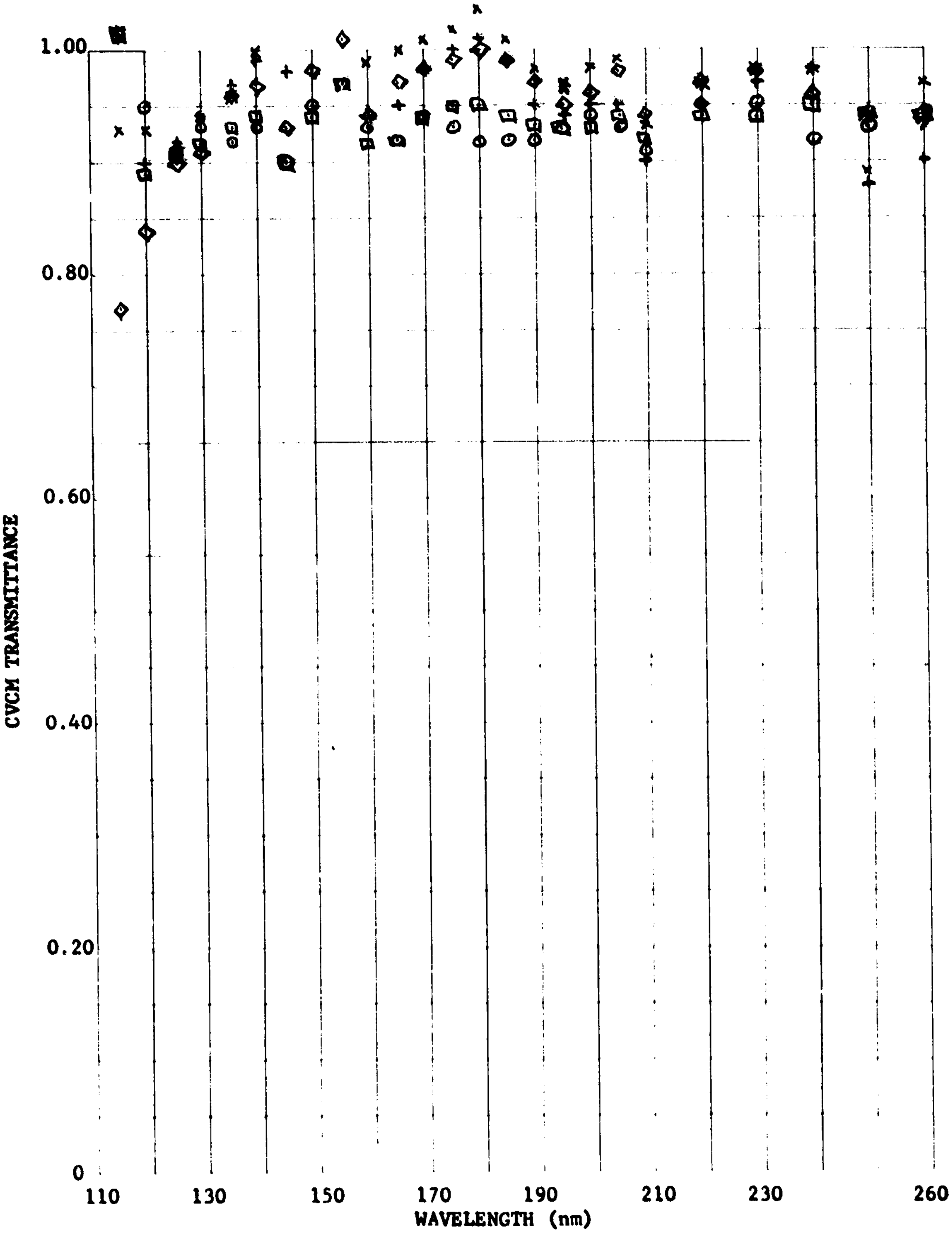

Figure 39. CVCM Transmittance Versus Wavelength, Source Material CAT-A-LAC 463-3-8, JPL#127-VOD-2, CVCM Thickness In Angstroms ○ 14, ▣ 14, ◆ 16, × 20, + 21.

Table LIX. CVCM Transmittance Versus Wavelength, Source Material CAT-A-LAC 463-3-8, JPL # 127-VOD-2, Source Temperature 55°C, MgF_2 Window Temperature -81°C, Chamber Pressure 4×10^{-6} Torr.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5
115	0.95	1.02	0.89	1.01	0.53	0.77	0.58	0.93	0.58	1.02
120	0.88	0.95	0.77	0.89	0.60	0.84	0.58	0.93	0.46	0.90
125	0.84	0.91	0.79	0.91	0.66	0.90	0.57	0.92	0.48	0.92
130	0.86	0.93	0.80	0.92	0.67	0.91	0.59	0.94	0.50	0.94
135	0.85	0.92	0.81	0.93	0.72	0.96	0.61	0.96	0.53	0.97
140	0.86	0.93	0.82	0.94	0.73	0.97	0.65	1.00	0.55	0.99
145	0.86	0.90	0.82	0.90	0.75	0.93	0.66	1.04	0.60	0.98
150	0.91	0.95	0.86	0.94	0.80	0.98	0.72	1.10	0.68	1.06
155	0.93	0.97	0.89	0.97	0.83	1.01	0.79	1.17	0.73	1.11
160	0.91	0.93	0.88	0.92	0.84	0.94	0.80	0.99	0.75	0.94
165	0.90	0.92	0.88	0.92	0.87	0.97	0.81	1.00	0.76	0.95
170	0.92	0.94	0.90	0.94	0.88	0.98	0.82	1.01	0.79	0.98
175	0.91	0.93	0.91	0.95	0.89	0.99	0.83	1.02	0.81	1.00
180	0.90	0.92	0.91	0.95	0.90	1.00	0.85	1.04	0.82	1.01
185	0.90	0.92	0.90	0.94	0.89	0.99	0.82	1.01	0.80	0.99
190	0.90	0.92	0.89	0.93	0.87	0.97	0.79	0.98	0.76	0.95
195	0.91	0.93	0.89	0.93	0.85	0.95	0.78	0.97	0.75	0.94
200	0.92	0.94	0.89	0.93	0.86	0.96	0.79	0.98	0.76	0.95
205	0.91	0.93	0.90	0.94	0.88	0.98	0.80	0.99	0.76	0.95
210	0.91	0.91	0.92	0.92	0.89	0.94	0.83	0.93	0.80	0.90
220	0.95	0.95	0.94	0.94	0.92	0.97	0.87	0.97	0.85	0.95
230	0.95	0.95	0.94	0.94	0.93	0.98	0.88	0.98	0.87	0.97
240	0.92	0.92	0.95	0.95	0.91	0.96	0.88	0.98	0.88	0.98
250	0.93	0.93	0.94	0.94	0.94	0.94	0.89	0.89	0.88	0.88
260	0.94	0.94	0.94	0.94	0.94	0.94	0.92	0.92	0.90	0.90
270	0.95	0.95	0.96	0.96	0.95	0.95	0.92	0.92	0.90	0.90
280	0.94	0.94	0.95	0.95	0.94	0.94	0.91	0.91	0.89	0.89
290	0.93	0.93	0.93	0.93	0.94	0.94	0.91	0.91	0.89	0.89
300	0.95	0.95	0.93	0.93	0.94	0.94	0.91	0.91	0.89	0.89
CVCM THICKNESS (A)	14		14		16		20		21	
TIME AFTER 100% SCAN (min)	133		382		1440		2865		4360	

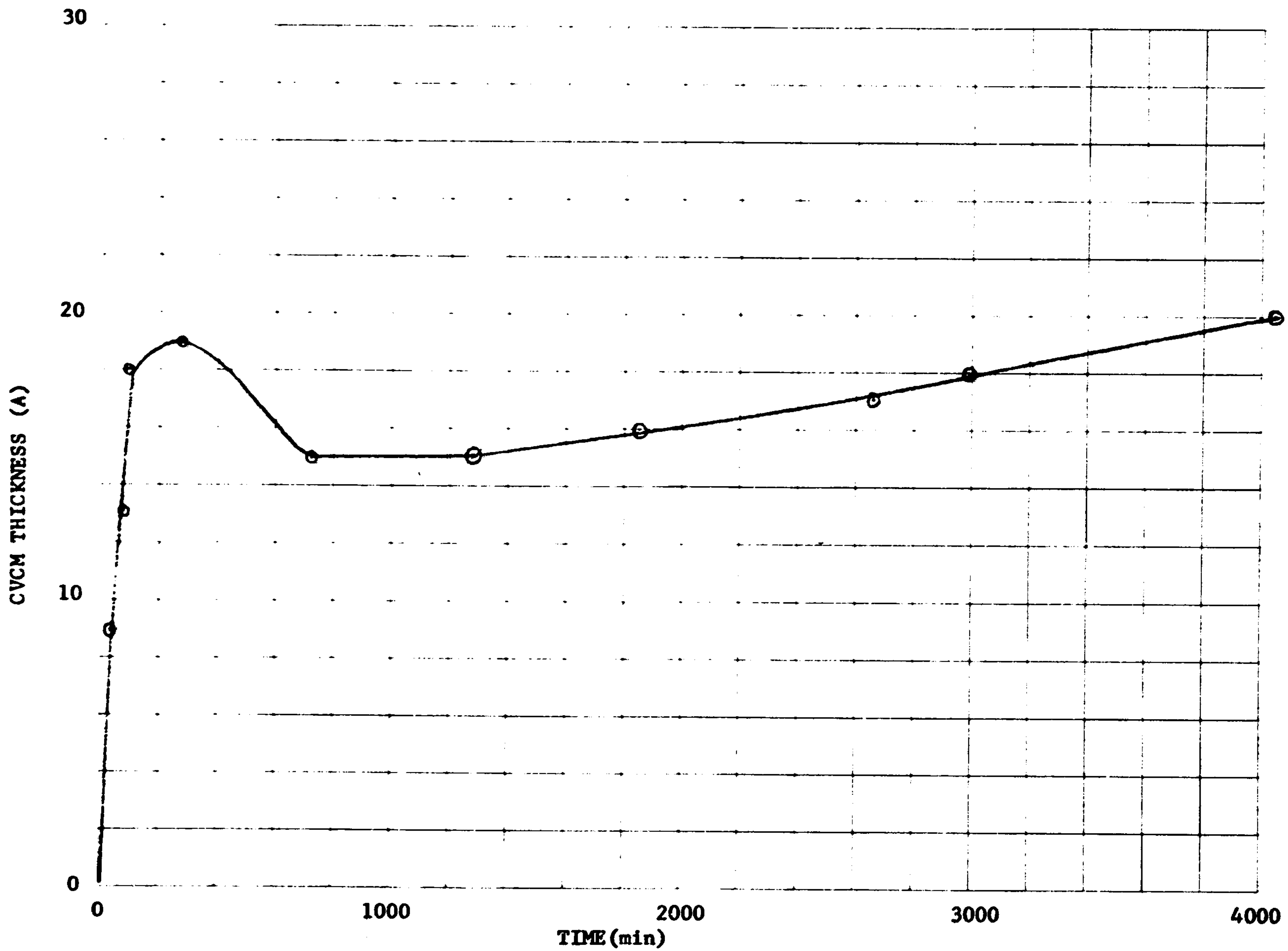

Figure 40. CVCM Thickness In Angstroms, Source Material Cat-A-Lac 436-3-8, JPL#127-VOD-2, Source Temperature 55°C, TQCM Temperature -76°C, TQCM Sensitivity $1.56x10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

CAT-A-LAC 463-3-8 OVER CAT-A-LAC 463-6-5 PRIMER

JPL#115B-VOD-1

WEIGHT: 0.2120 g, PAINT THICKNESS (2 COATS) 0.00572 cm, PRIMER 0.00089 cm

CURE: 16 HR @ AMBIENT; AMBIENT PRESSURE

SOURCE TEMPERATURE: 55°C

WINDOW TEMPERATURE: -83°C

TQCM TEMPERATURE: -85°C

COMMENTS: RELATIVELY LOW OUTGASSING MATERIAL, DEPOSITION SO LOW THAT BACKGROUND NORMALIZATION SIGNIFICANT PORTION OF DATA

WARMED TO -40°C, SLIGHT INCREASE (5%) IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 1.00 @ 120 nm
T = 0.87 @ 300 nm

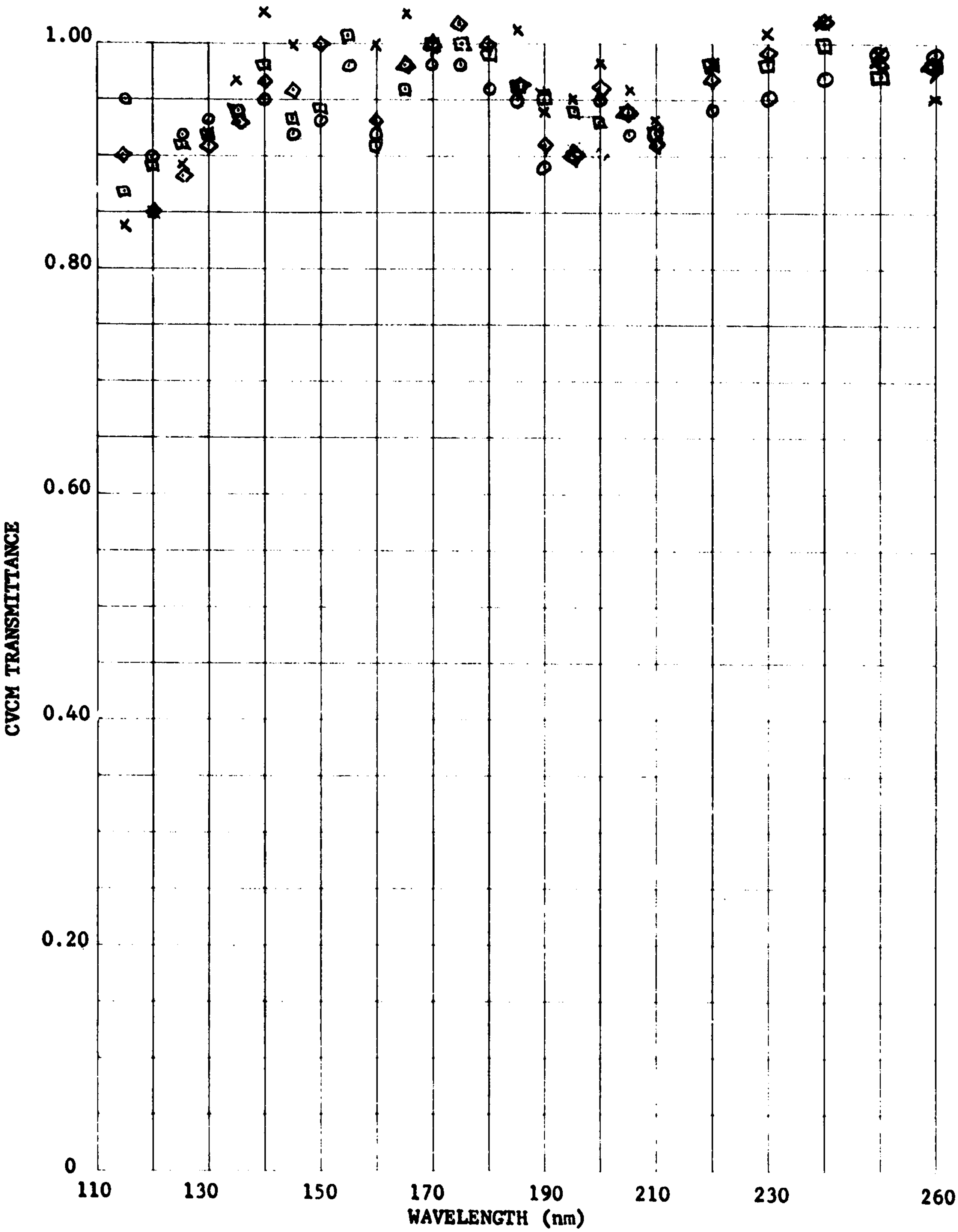

Figure 41. CVCM Transmittance Versus Wavelength, Source Material CAT-A-LAC 463-3-8/ 463-6-5, JPL#115B-VOD-1, CVCM Thickness In Angstroms ⊙ 16, ⊡ 10, ◆ 14, × 12.

Table LX. CVCM Transmittance Versus Wavelength, Source Material CAT-A-LAC 463-3-8/463-6-5 Primer, JPL#115B-VOD-1, Source Temperature 55°C, MgF_2 Window Temperature -83°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.85	0.95	0.62	0.87	0.55	0.90	0.40	0.84
120	0.80	0.90	0.64	0.89	0.50	0.85	0.41	0.85
125	0.82	0.92	0.66	0.91	0.53	0.88	0.45	0.89
130	0.83	0.93	0.67	0.92	0.56	0.91	0.49	0.93
135	0.84	0.94	0.69	0.94	0.58	0.93	0.53	0.97
140	0.85	0.95	0.73	0.98	0.62	0.97	0.59	1.03
145	0.86	0.92	0.74	0.93	0.67	0.96	0.62	1.00
150	0.87	0.93	0.75	0.94	0.71	1.00	0.71	1.09
155	0.92	0.98	0.82	1.01	0.80	1.09	0.80	1.18
160	0.89	0.92	0.81	0.91	0.78	0.93	0.81	1.00
165	0.95	0.98	0.86	0.96	0.83	0.98	0.84	1.03
170	0.95	0.98	0.90	1.00	0.85	1.00	0.90	1.09
175	0.95	0.98	0.90	1.00	0.87	1.02	0.88	1.07
180	0.93	0.96	0.89	0.99	0.85	1.00	0.87	1.06
185	0.92	0.95	0.86	0.96	0.81	0.96	0.83	1.02
190	0.86	0.89	0.80	0.90	0.76	0.91	0.75	0.94
195	0.87	0.90	0.84	0.94	0.75	0.90	0.76	0.95
200	0.92	0.95	0.83	0.93	0.81	0.96	0.79	0.98
205	0.89	0.92	0.84	0.94	0.79	0.94	0.77	0.96
210	0.92	0.92	0.87	0.92	0.83	0.91	0.83	0.93
220	0.94	0.94	0.93	0.98	0.89	0.97	0.88	0.98
230	0.95	0.95	0.93	0.98	0.91	0.99	0.91	1.01
240	0.97	0.97	0.95	1.00	0.94	1.02	0.92	1.02
250	0.99	0.99	0.97	0.97	0.98	0.98	0.99	0.99
260	0.99	0.99	0.98	0.98	0.98	0.98	0.95	0.95
270	0.99	0.99	0.94	0.94	0.95	0.95	0.93	0.93
280	0.93	0.93	0.95	0.95	0.94	0.94	0.94	0.94
290	0.97	0.97	0.96	0.96	0.94	0.94	0.97	0.97
300	0.96	0.96	0.95	0.95	0.95	0.95	0.96	0.96
CVCM THICKNESS (A)	16		10		14		12	
TIME AFTER 100% SCAN (min)	256		1510		2900		4325	

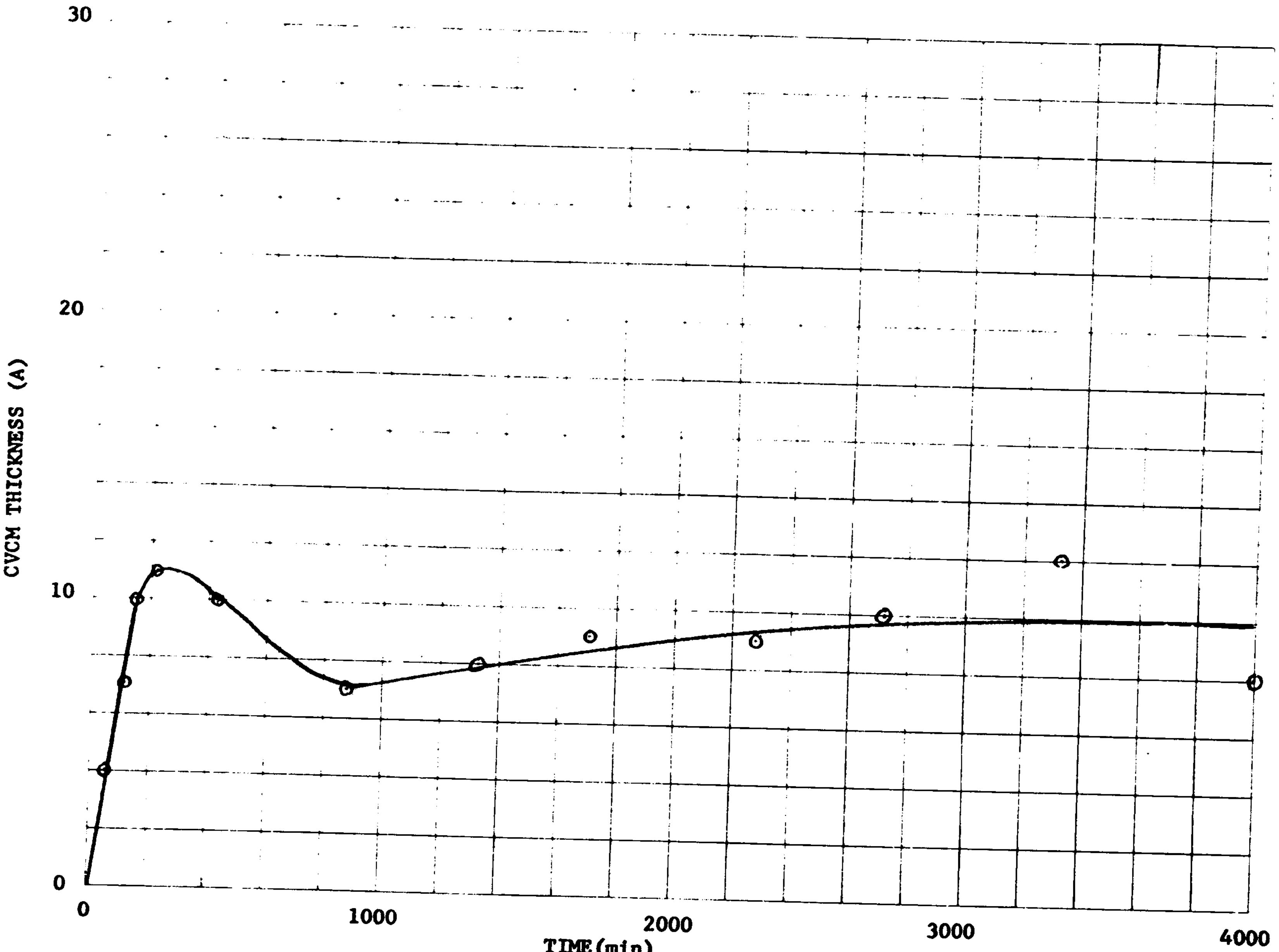

Figure 42. CVCM Thickness In Angstroms, Source Material Cat-A-Lac 463-3-8/463-6-5, JPL#115B-VOD-1, Source Temperature 55°C, TQCM Temperature -85°C, TQCM Sensitivity $1.56\times10^{-9}g.cm^{-2}.Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

CAT-A-LAC 463-3-8 OVER CAT-A-LAC 463-6-5 PRIMER

JPL#115B-VOD-2

WEIGHT: 0.2951 g

CURE: 16 HR @ AMBIENT; AMBIENT PRESSURE
24 HR @ 176°F; VACUUM

SOURCE TEMPERATURE: 56°C

WINDOW TEMPERATURE: -79°C

TQCM TEMPERATURE: -79°C

COMMENTS: RELATIVELY LOW OUTGASSING MATERIAL

NO SIGNIFICANT REDUCTION IN CVCM BY VACUUM BAKE AT 176°F

WARMED TO -40°C, NO AFFECT ON TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 0.84 @ 120 nm
T = 0.75 @ 300 nm

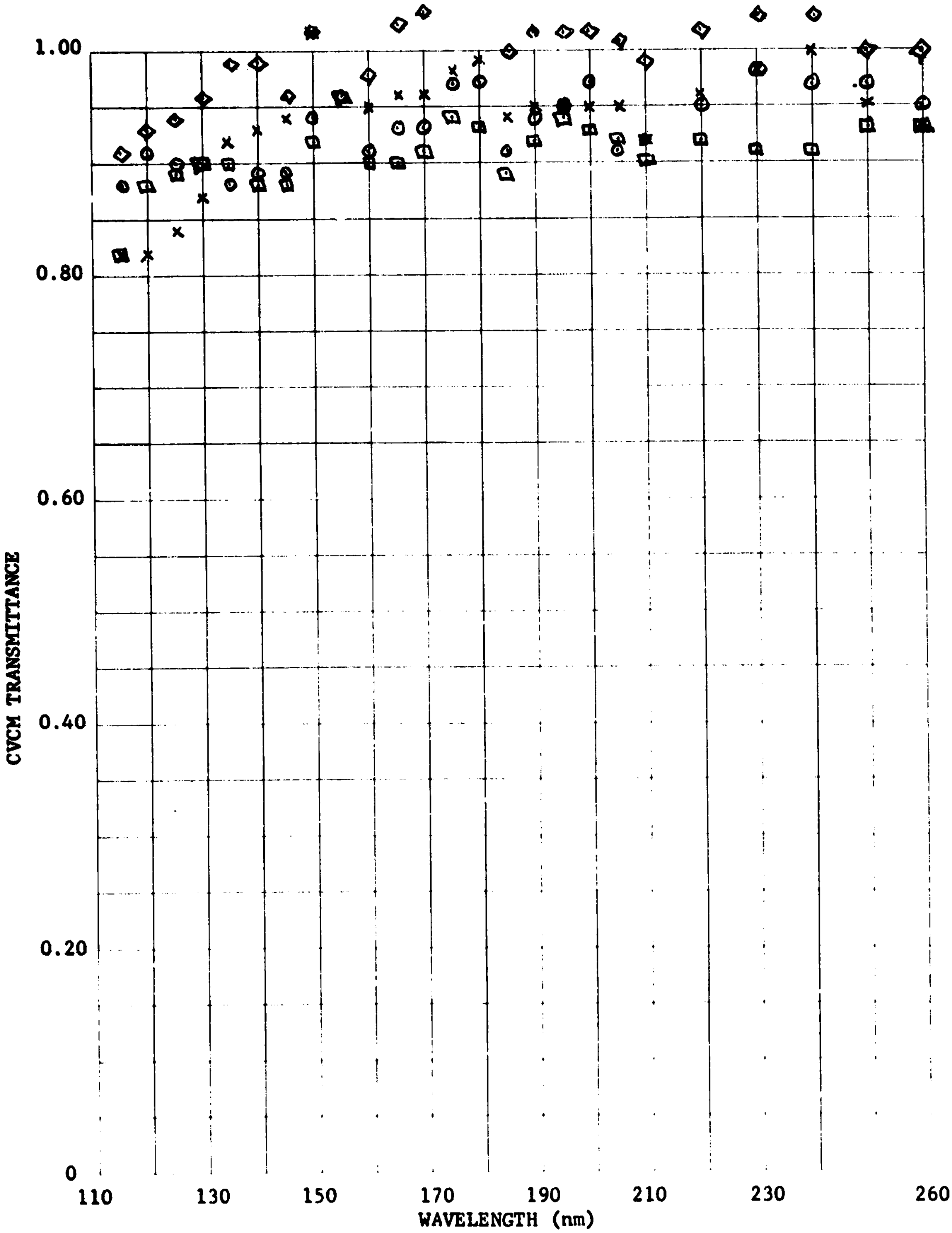

Figure 43. CVCM Transmittance Versus Wavelength, Source Material CAT-A-LAC 463-3-8/ 463-6-5, JPL#115B-VOD-2, CVCM Thickness In Angstroms ○ 19, ⧠ 20, ◇ 15, × 24.

Table LXI. CVCM Transmittance Versus Wavelength, Source Material CAT-A-LAC 463-3-8/463-6-5, JPL #115B-VOD-2, Source Temperature 56°C, MgF_2 Window Temperature -79°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4
115	0.79	0.88	0.70	0.82	0.67	0.91	0.47	0.82
120	0.82	0.91	0.76	0.88	0.69	0.93	0.47	0.82
125	0.81	0.90	0.77	0.89	0.70	0.94	0.49	0.84
130	0.81	0.90	0.78	0.90	0.72	0.96	0.52	0.87
135	0.79	0.88	0.78	0.90	0.75	0.99	0.57	0.92
140	0.80	0.89	0.76	0.88	0.75	0.99	0.58	0.93
145	0.83	0.89	0.79	0.88	0.78	0.96	0.65	0.94
150	0.88	0.94	0.83	0.92	0.84	1.02	0.73	1.02
155	0.90	0.96	0.87	0.96	0.87	1.05	0.77	1.06
160	0.88	0.91	0.86	0.90	0.88	0.98	0.80	0.95
165	0.90	0.93	0.86	0.90	0.93	1.03	0.81	0.96
170	0.90	0.93	0.87	0.91	0.94	1.04	0.81	0.96
175	0.94	0.97	0.90	0.94	0.97	1.07	0.83	0.98
180	0.94	0.97	0.89	0.93	0.95	1.05	0.84	0.99
185	0.88	0.91	0.85	0.89	0.90	1.00	0.79	0.94
190	0.91	0.94	0.88	0.92	0.92	1.02	0.80	0.95
195	0.92	0.95	0.90	0.94	0.92	1.02	0.80	0.95
200	0.94	0.97	0.89	0.93	0.92	1.02	0.80	0.95
205	0.88	0.91	0.88	0.92	0.91	1.01	0.80	0.95
210	0.92	0.92	0.90	0.90	0.94	0.99	0.84	0.92
220	0.95	0.95	0.92	0.92	0.97	1.02	0.88	0.96
230	0.98	0.98	0.91	0.91	0.99	1.04	0.90	0.98
240	0.97	0.97	0.91	0.91	0.99	1.04	0.92	1.00
250	0.97	0.97	0.93	0.93	1.00	1.00	0.95	0.95
260	0.95	0.95	0.93	0.93	1.00	1.00	0.93	0.93
270	0.97	0.97	0.97	0.97	1.02	1.02	0.95	0.95
280	0.97	0.97	0.97	0.97	1.01	1.01	0.96	0.96
290	0.95	0.95	0.94	0.94	1.01	1.01	0.95	0.95
300	0.96	0.96	0.93	0.93	0.99	0.99	0.93	0.93
CVCM THICKNESS (A)	19		20		15		24	
TIME AFTER 100% SCAN (min)	219		489		1411		2879	

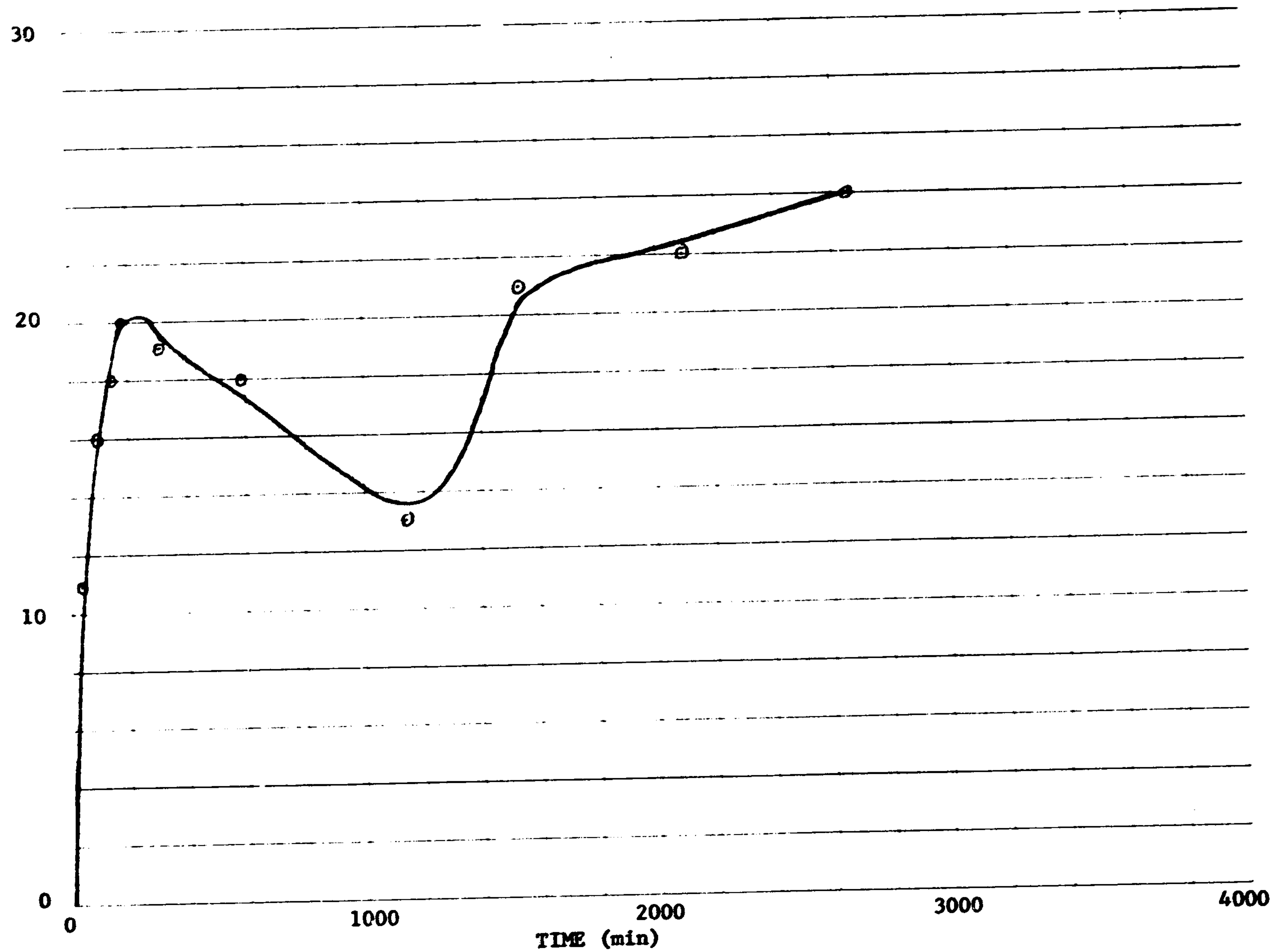

Figure 44. CVCM Thickness In Angstroms Versus Time, Source Material Cat-A-Lac 463-3-8/463-6-5, JPL#115B-VOD-2, Source Temperature 56°C, TQCM Temperature -79°C, TQCM Sensitivity 1.56×10^{-9} $g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

3M NEXTEL 401-C10 UNPRIMED

JPL#143-VOD-1

WEIGHT: 0.3157 g

CURE: 2 HR @ 95°F; AMBIENT PRESSURE
1 HR @ 150°F; AMBIENT PRESSURE

SOURCE TEMPERATURE: 54°C

WINDOW TEMPERATURE: -82°C

TQCM TEMPERATURE: -82°C

COMMENTS: RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm

WARMED TO -40°C, NO AFFECT ON TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 1.22 @ 120 nm
T = 0.88 @ 300 nm

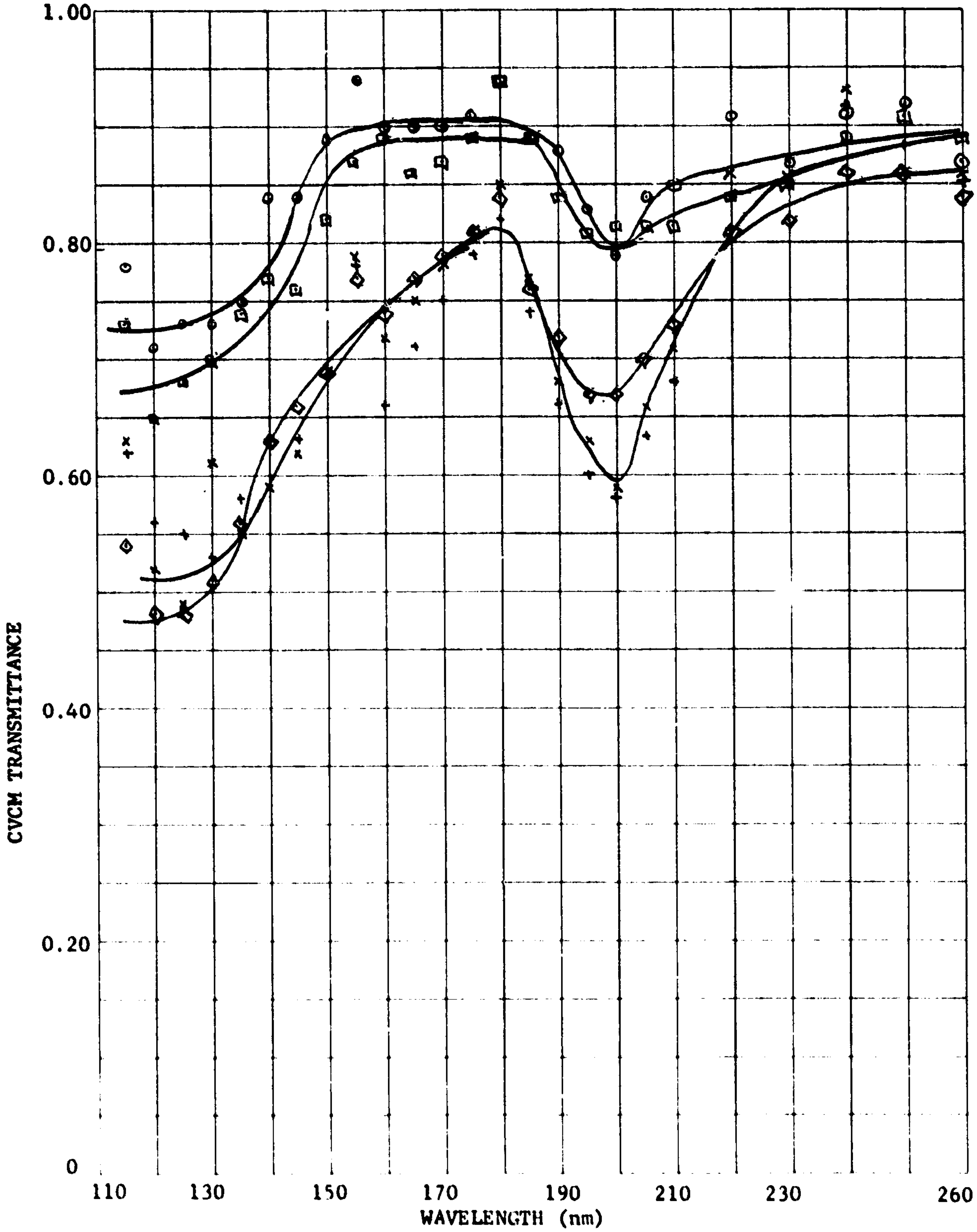

Figure 55. CVCM Transmittance Versus Wavelength, Source Material 3M Nextel 401-C10, JPL#143-VOD-1, CVCM Thickness In Angstroms ○ 67, ◻ 106, ◇ 233, × 310, + 365.

Table LXII. CVCM Transmittance Versus Wavelength, Source Material 3M Nextel 401-C10, JPL#143-VOD-1, Source Temperature 54°C, MgF_2 Window Temperature -82°C.

WAVELENGTH (nm)	CVCM TRANSMITTANCE									
	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5
115	0.71	0.78	0.60	0.73	0.30	0.54	0.28	0.63	0.18	0.62
120	0.64	0.71	0.52	0.65	0.24	0.48	0.17	0.52	0.12	0.56
125	0.66	0.73	0.55	0.68	0.24	0.48	0.14	0.49	0.11	0.55
130	0.66	0.73	0.57	0.70	0.27	0.51	0.36	0.61	0.09	0.53
135	0.68	0.75	0.61	0.74	0.32	0.56	0.20	0.55	0.14	0.58
140	0.77	0.84	0.64	0.77	0.39	0.63	0.24	0.59	0.19	0.63
145	0.79	0.84	0.67	0.76	0.48	0.66	0.32	0.62	0.25	0.63
150	0.84	0.89	0.73	0.82	0.51	0.69	0.39	0.69	0.36	0.74
155	0.89	0.94	0.78	0.87	0.59	0.77	0.49	0.79	0.40	0.78
160	0.88	0.90	0.84	0.89	0.64	0.74	0.57	0.72	0.47	0.66
165	0.88	0.90	0.81	0.86	0.67	0.77	0.60	0.75	0.52	0.71
170	0.88	0.90	0.82	0.87	0.69	0.79	0.63	0.78	0.56	0.75
175	0.89	0.91	0.84	0.89	0.71	0.81	0.66	0.81	0.60	0.79
180	0.92	0.94	0.89	0.94	0.74	0.84	0.70	0.85	0.63	0.82
185	0.87	0.89	0.84	0.89	0.66	0.76	0.62	0.77	0.55	0.74
190	0.86	0.88	0.79	0.84	0.62	0.72	0.53	0.68	0.47	0.66
195	0.81	0.83	0.76	0.81	0.57	0.67	0.48	0.63	0.41	0.60
200	0.77	0.79	0.77	0.82	0.57	0.67	0.44	0.59	0.39	0.58
205	0.82	0.84	0.77	0.82	0.60	0.70	0.51	0.66	0.44	0.63
210	0.85	0.85	0.82	0.82	0.68	0.73	0.63	0.71	0.58	0.68
220	0.91	0.91	0.84	0.84	0.76	0.81	0.78	0.86	0.71	0.81
230	0.87	0.87	0.85	0.85	0.77	0.82	0.78	0.86	0.75	0.85
240	0.91	0.91	0.89	0.89	0.81	0.86	0.85	0.93	0.82	0.92
250	0.92	0.92	0.91	0.91	0.86	0.86	0.86	0.86	0.88	0.88
260	0.87	0.87	0.89	0.89	0.84	0.84	0.86	0.86	0.85	0.85
270	0.93	0.93	0.91	0.91	0.83	0.83	0.88	0.88	0.88	0.88
280	0.95	0.95	0.92	0.92	0.86	0.86	0.87	0.87	0.88	0.88
290	0.95	0.95	0.94	0.94	0.91	0.91	0.90	0.90	0.91	0.91
300	0.98	0.98	0.97	0.97	0.91	0.91	0.94	0.94	0.94	0.94
CVCM THICKNESS (A)	67		106		233		310		365	
TIME AFTER 100% SCAN (min)	155		408		1390		2969		4456	

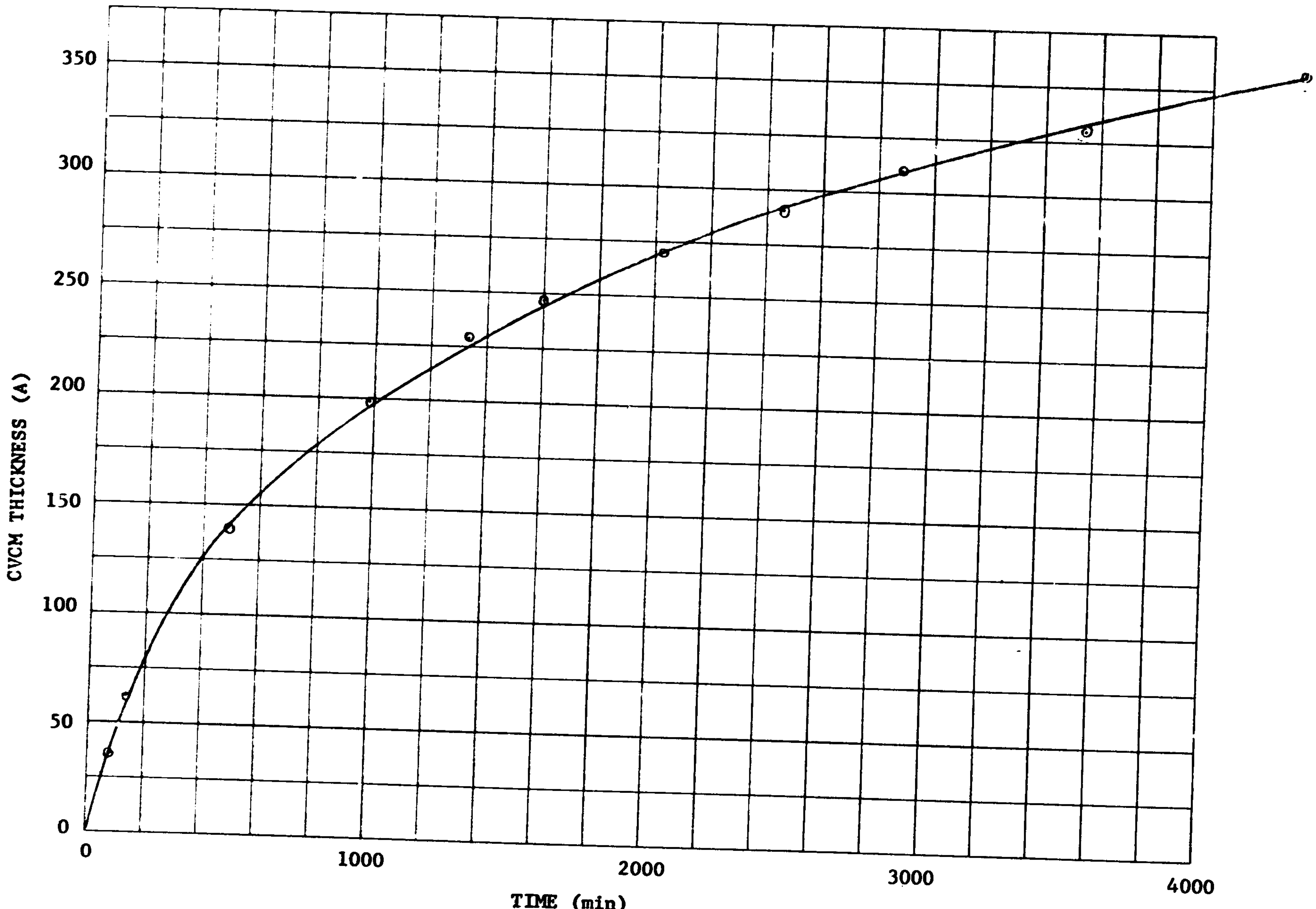

Figure 46. CVCM Thickness In Angstroms, Source Material 3M Nextel 401-C10, JPL#143-VOD-1, Source Temperature 54°C, TQCM Temperature -82°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

3M NEXTEL 401-C10 UNPRIMED

JPL#143-VOD-2

WEIGHT: 0.2512 g

CURE: 2 HR @ 95°F, 1 HR @ 150°F; AMBIENT PRESSURE
24 HR @ 176°F; VACUUM

SOURCE TEMPERATURE: 49°C AND 124°C

WINDOW TEMPERATURE: -75°C

TQCM TEMPERATURE: -82°C

COMMENTS: ERROR IN HEATING SETTING CAUSED SOURCE TEMPERATURE TO EXCEED 49°C FOR 24 MIN, REACHING 124°C; RESET AT 49°C

VACUUM BAKE DID REDUCE THE CVCM DEPOSITION

RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm

WARMED TO -41°C INCREASED TRANSMITTANCE ABOUT A FACTOR OF 2 FOR WAVELENGTHS LESS THAN 150 nm

AFTER TEST, AMBIENT TEMPERATURE, T = 0.77 @ 120 nm
T = 0.79 @ 300 nm

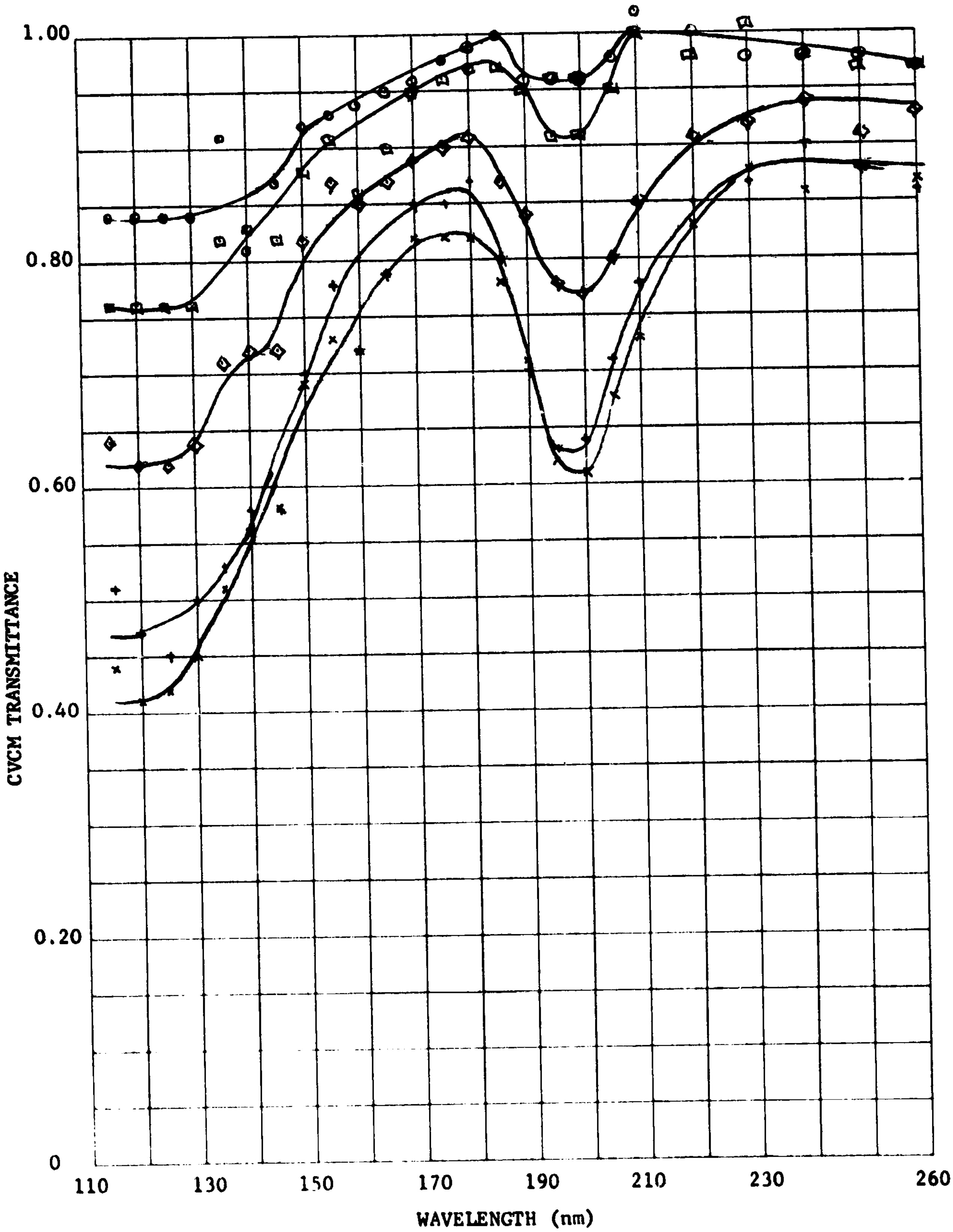

Figure 47. CVCM Transmittance Versus Wavelength, Source Material 3M Nextel 401-C10, JPL#143-VOD-2, CVCM Thickness In Angstroms ○ 26, ◻ 42, ◇ 97, × 222, + 237.

Table LXIII. CVCM Transmittance Versus Wavelength, Source Material 3M Nextel 401-C10, JPL #143-VOD-2, Source Temperature 49°C/124°C, MgF_2 Window Temperature -75°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5
115	0.80	0.84	0.68	0.76	0.42	0.64	0.21	0.44	0.18	0.51
120	0.80	0.84	0.68	0.76	0.40	0.62	0.18	0.41	0.14	0.47
125	0.80	0.84	0.68	0.76	0.40	0.62	0.19	0.42	0.12	0.45
130	0.80	0.84	0.68	0.76	0.42	0.64	0.22	0.45	0.17	0.50
135	0.87	0.91	0.74	0.82	0.49	0.71	0.28	0.51	0.20	0.53
140	0.85	0.81	0.75	0.83	0.50	0.72	0.33	0.56	0.25	0.58
145	0.85	0.87	0.77	0.82	0.56	0.72	0.41	0.58	0.31	0.58
150	0.90	0.92	0.83	0.88	0.66	0.82	0.52	0.69	0.43	0.70
155	0.91	0.93	0.86	0.91	0.71	0.87	0.56	0.73	0.51	0.78
160	0.93	0.94	0.84	0.86	0.76	0.85	0.62	0.72	0.58	0.72
165	0.94	0.95	0.88	0.90	0.78	0.87	0.69	0.79	0.65	0.79
170	0.95	0.96	0.93	0.95	0.80	0.89	0.72	0.82	0.71	0.85
175	0.97	0.98	0.94	0.96	0.81	0.90	0.72	0.82	0.71	0.85
180	0.98	0.99	0.95	0.97	0.82	0.91	0.72	0.82	0.73	0.87
185	0.99	1.00	0.95	0.97	0.79	0.87	0.68	0.78	0.66	0.80
190	0.95	0.96	0.93	0.95	0.75	0.84	0.61	0.71	0.56	0.70
195	0.95	0.96	0.89	0.91	0.69	0.78	0.52	0.62	0.49	0.63
200	0.95	0.96	0.89	0.91	0.68	0.77	0.51	0.61	0.50	0.64
205	0.97	0.98	0.93	0.95	0.71	0.80	0.58	0.68	0.57	0.71
210	1.02	1.02	1.00	1.00	0.81	0.85	0.69	0.73	0.70	0.78
220	1.00	1.00	0.98	0.98	0.87	0.91	0.79	0.83	0.77	0.85
230	0.98	0.98	1.01	1.01	0.88	0.92	0.84	0.88	0.79	0.87
240	0.98	0.98	0.98	0.98	0.90	0.94	0.82	0.86	0.82	0.90
250	0.98	0.98	0.97	0.97	0.91	0.91	0.88	0.88	0.87	0.87
260	0.97	0.97	0.97	0.97	0.93	0.93	0.87	0.87	0.86	0.86
270	0.97	0.97	0.98	0.98	0.94	0.94	0.86	0.86	0.88	0.88
280	0.99	0.99	0.99	0.99	0.97	0.97	0.89	0.89	0.89	0.89
290	1.01	1.01	1.00	1.00	0.95	0.95	0.92	0.92	0.90	0.90
300	0.95	0.95	0.97	0.97	0.92	0.92	0.94	0.94	0.87	0.87
CVCM THICKNESS (A)	26		42		97		222		237	
TIME AFTER 100% SCAN (min)	63		183		1161		1257		2614	

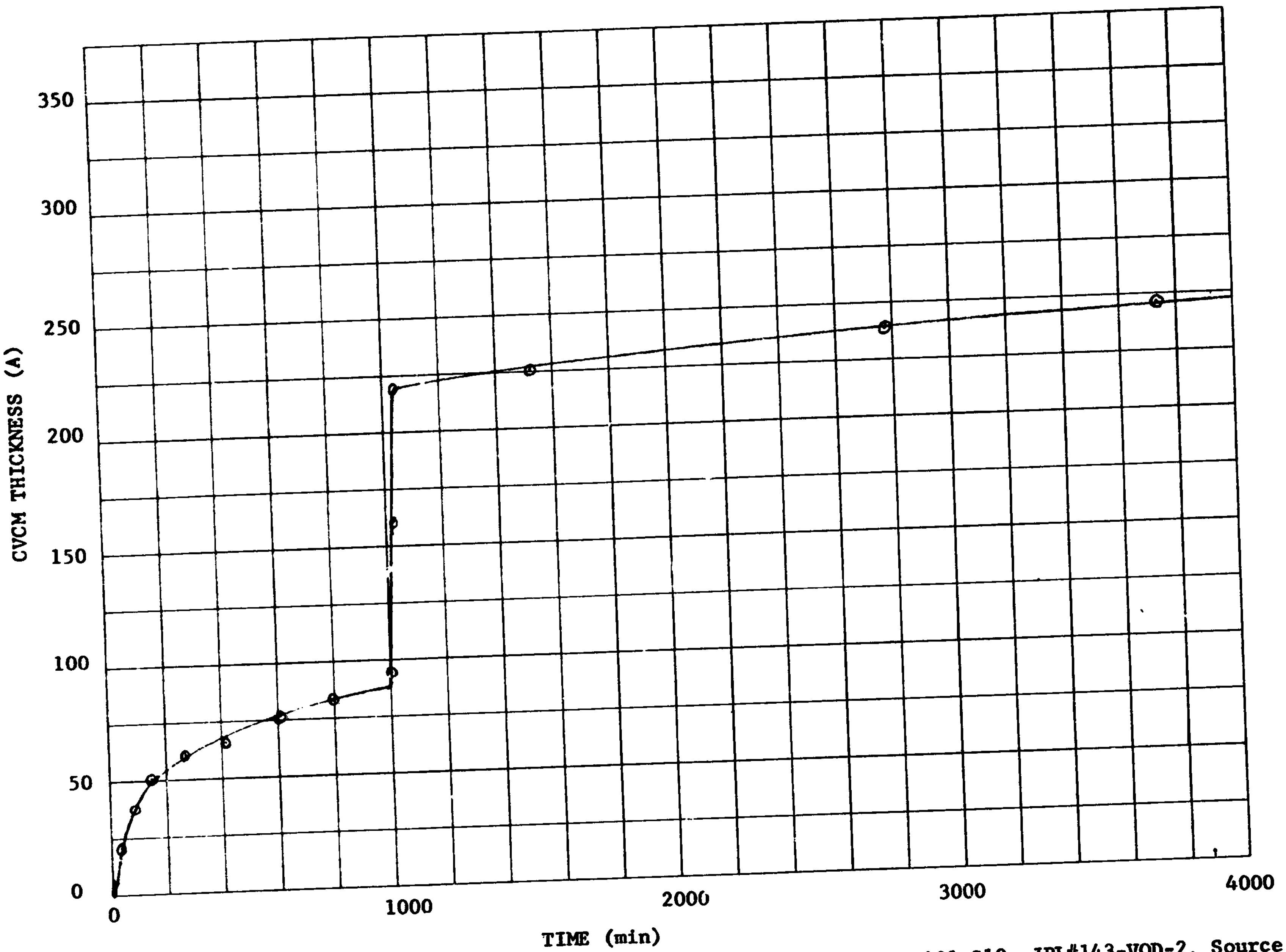

Figure 48. CVCM Thickness In Angstroms Versus Time, Source Material 3M Nextel 401-C10, JPL#143-VOD-2, Source Temperature 49°C (At 1000 min, Exceeded 49°C For 24 min Reaching 124°C), TQCM Temperature -82°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

3M NEXTEL 401-C10 OVER 901-P1 PRIMER

JPL#144-VOD-1

WEIGHT: 0.2975 g

CURE: 2 HR @ 95°F, 1 HR @ 150°F; AMBIENT PRESSURE

SOURCE TEMPERATURE: 52°C AND 127°C

WINDOW TEMPERATURE: -79°C

TQCM TEMPERATURE: -82°C

COMMENTS: STRONG ABSORPTION NEAR 200 nm

ERROR IN HEATING SETTING CAUSED TEMPERATURE TO EXCEED 52°C FOR 18 min, REACHING 127°C, RESET AT 52°C

WARMED TO -40°C, NO EFFECT IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 1.26 @ 120 nm
T = 0.85 @ 300 nm

INCREASE IN CVCM DUE TO PRIMER, ABOUT A FACTOR OF 3

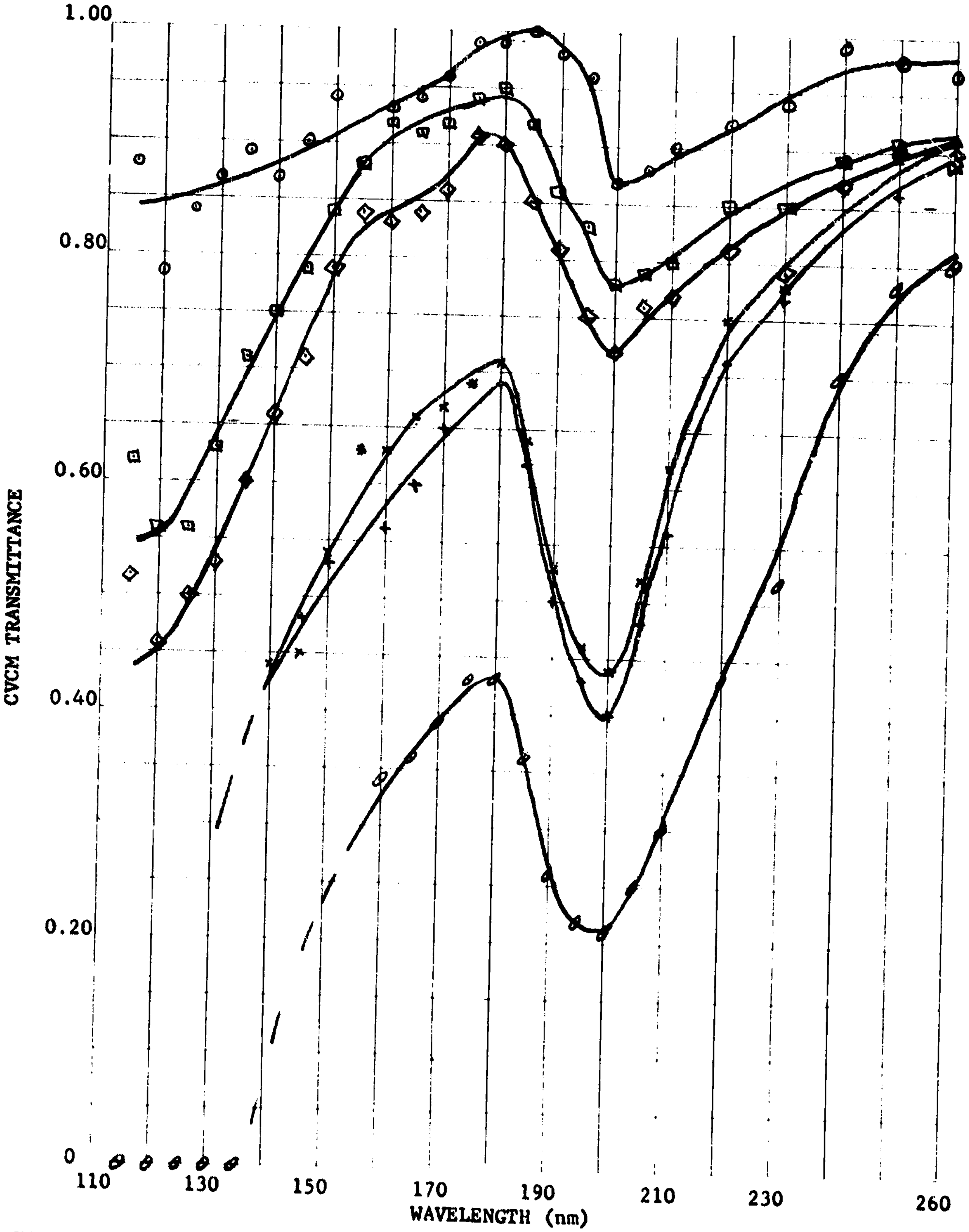

Figure 49. CVCM Transmittance Versus Wavelength, Source Material 3M Nextel 401-C10/901-P1, JPL#144-VOD-1, CVCM Thickness In Angstroms ⊙ 44, ⊡ 116, ◇ 159, × 404, + 492, ⌀ 1013.

Table LXIV. CVCM Transmittance Versus Wavelength, Source Material 3M Nextel 401-C10/901-P1, JPL #144-VOD-1, Source Temperature 52°C/127°C For T_6, MgF_2 Window Temperature -79°C, Chamber Pressure $2x10^{-6}$ Torr.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5	T	T_6
115	0.84	0.88	0.52	0.62	0.39	0.52	0.12	--	0.12	--	0.00	0.00
120	0.74	0.78	0.46	0.56	0.33	0.46	0.08	--	0.08	--	0.00	0.00
125	0.80	0.84	0.46	0.56	0.37	0.50	0.07	--	0.07	--	0.00	0.00
130	0.83	0.87	0.53	0.63	0.40	0.53	0.11	--	0.06	--	0.00	0.00
135	0.85	0.89	0.61	0.71	0.47	0.60	0.15	--	0.10	--	0.00	0.00
140	0.83	0.87	0.65	0.75	0.53	0.66	0.20	0.44	0.12	--	0.02	--
145	0.88	0.90	0.73	0.79	0.62	0.71	0.27	0.45	0.19	0.48	0.03	--
150	0.92	0.94	0.78	0.84	0.70	0.79	0.36	0.54	0.24	0.53	0.09	--
155	0.86	0.88	0.82	0.88	0.75	0.84	0.45	0.63	0.34	0.63	0.14	--
160	0.92	0.93	0.89	0.92	0.78	0.83	0.53	0.63	0.41	0.56	0.19	0.34
165	0.93	0.94	0.88	0.91	0.79	0.84	0.56	0.66	0.45	0.60	0.21	0.36
170	0.95	0.96	0.89	0.92	0.81	0.86	0.57	0.67	0.50	0.65	0.24	0.39
175	0.98	0.99	0.91	0.94	0.86	0.91	0.59	0.69	0.54	0.69	0.28	0.43
180	0.98	0.99	0.92	0.95	0.85	0.90	0.61	0.71	0.54	0.69	0.28	0.43
185	0.99	1.00	0.89	0.92	0.80	0.85	0.54	0.64	0.47	0.62	0.21	0.36
190	0.97	0.98	0.83	0.86	0.76	0.81	0.43	0.53	0.35	0.50	0.11	0.26
195	0.95	0.96	0.80	0.83	0.70	0.75	0.36	0.46	0.28	0.43	0.07	0.22
200	0.86	0.87	0.75	0.78	0.67	0.72	0.34	0.44	0.25	0.40	0.06	0.21
205	0.87	0.88	0.76	0.79	0.71	0.76	0.42	0.52	0.33	0.48	0.10	0.25
210	0.90	0.90	0.80	0.80	0.77	0.77	0.57	0.62	0.48	0.56	0.22	0.30
220	0.92	0.92	0.85	0.85	0.81	0.81	0.70	0.75	0.63	0.71	0.35	0.43
230	0.94	0.94	0.85	0.85	0.79	0.79	0.73	0.78	0.69	0.77	0.44	0.52
240	0.99	0.99	0.89	0.89	0.87	0.87	0.82	0.87	0.81	0.89	0.62	0.70
250	0.98	0.98	0.91	0.91	0.90	0.90	0.90	0.90	0.86	0.86	0.78	0.78
260	0.97	0.97	0.89	0.89	0.90	0.90	0.89	0.89	0.91	0.91	0.80	0.80
270	0.93	0.93	0.90	0.90	0.88	0.88	0.87	0.87	0.90	0.90	0.78	0.78
280	0.98	0.98	0.94	0.94	0.93	0.93	0.92	0.92	0.94	0.94	0.82	0.82
290	1.01	1.01	0.97	0.97	0.95	0.95	0.95	0.95	0.97	0.97	0.88	0.88
300	0.98	0.98	0.96	0.96	0.95	0.95	0.93	0.93	0.98	0.98	0.91	0.91
CVCM THICKNESS (A)	44		116		159		404		492		1013	
TIME AFTER 100% SCAN (min)	74		255		442		1479		2908		2983	

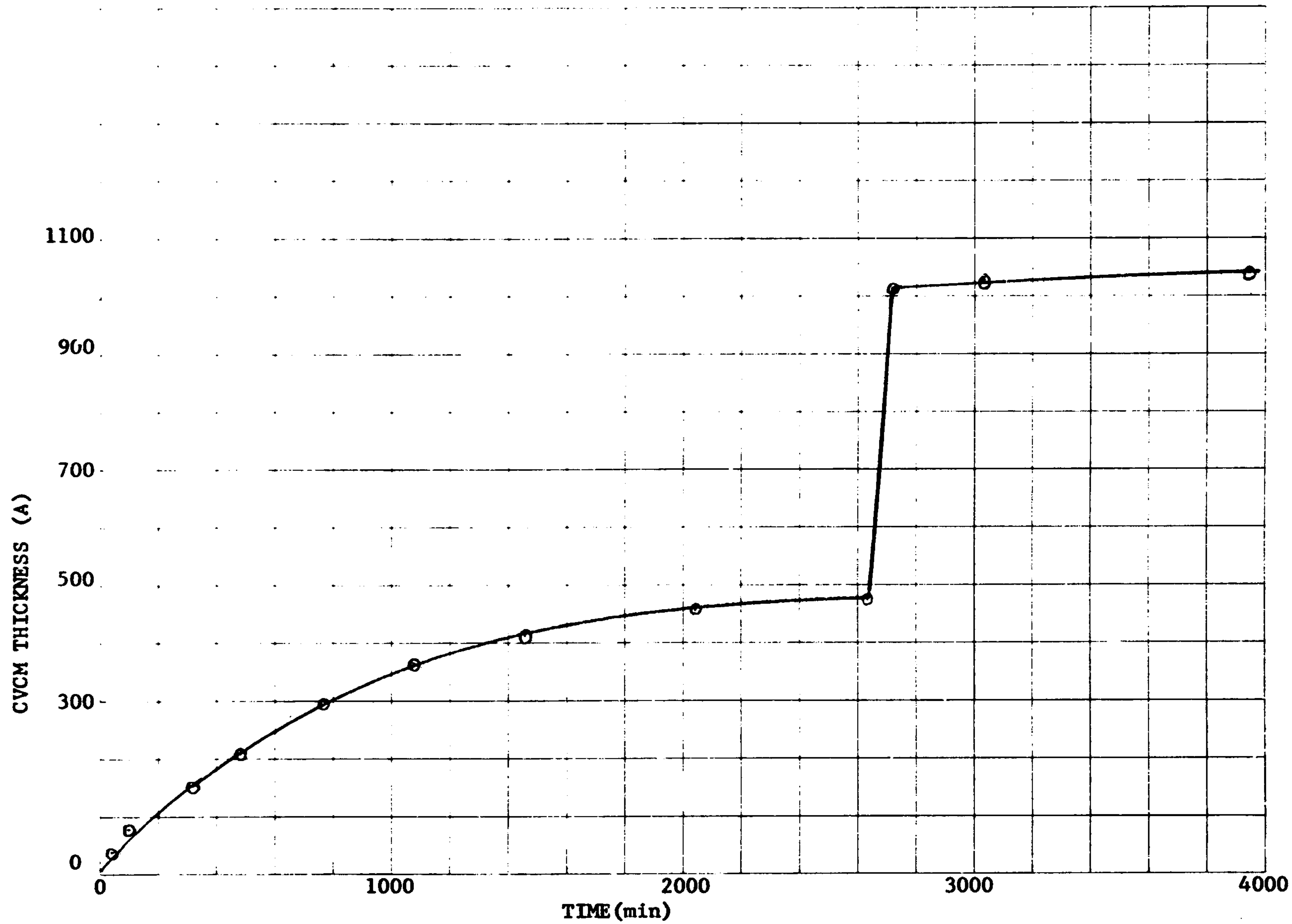

Figure 50. CVCM Thickness In Angstroms, Source Material 3M Nextel 401-C10/901-P1, JPL#144-VOD-1, Source Temperature $52^{\circ}C$ At 2687 Min(above $52^{\circ}C$,18 Min@$127^{\circ}C$)TQCM Temperature $-82^{\circ}C$, TQCM Sensitivity $1.56 \times 10^{-9} g.cm^{-2}.Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

3M NEXTEL 401-C10 OVER 901-P1 PRIMER

JPL#144-VOD-2

WEIGHT: 0.3311 g

CURE: 2 HR @ 95°F, 1 HR @ 150°F; AMBIENT PRESSURE
24 HR @ 176°F; VACUUM

SOURCE TEMPERATURE: 52°C

WINDOW TEMPERATURE: -75°C

TQCM TEMPERATURE: -82°C

COMMENTS: RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm

SLIGHT DECREASE IN CVCM DEPOSITION DUE TO VACUUM BAKE

WARMED TO -40°C, NO EFFECT IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 1.14 @ 120 nm
T = 0.90 @ 300 nm

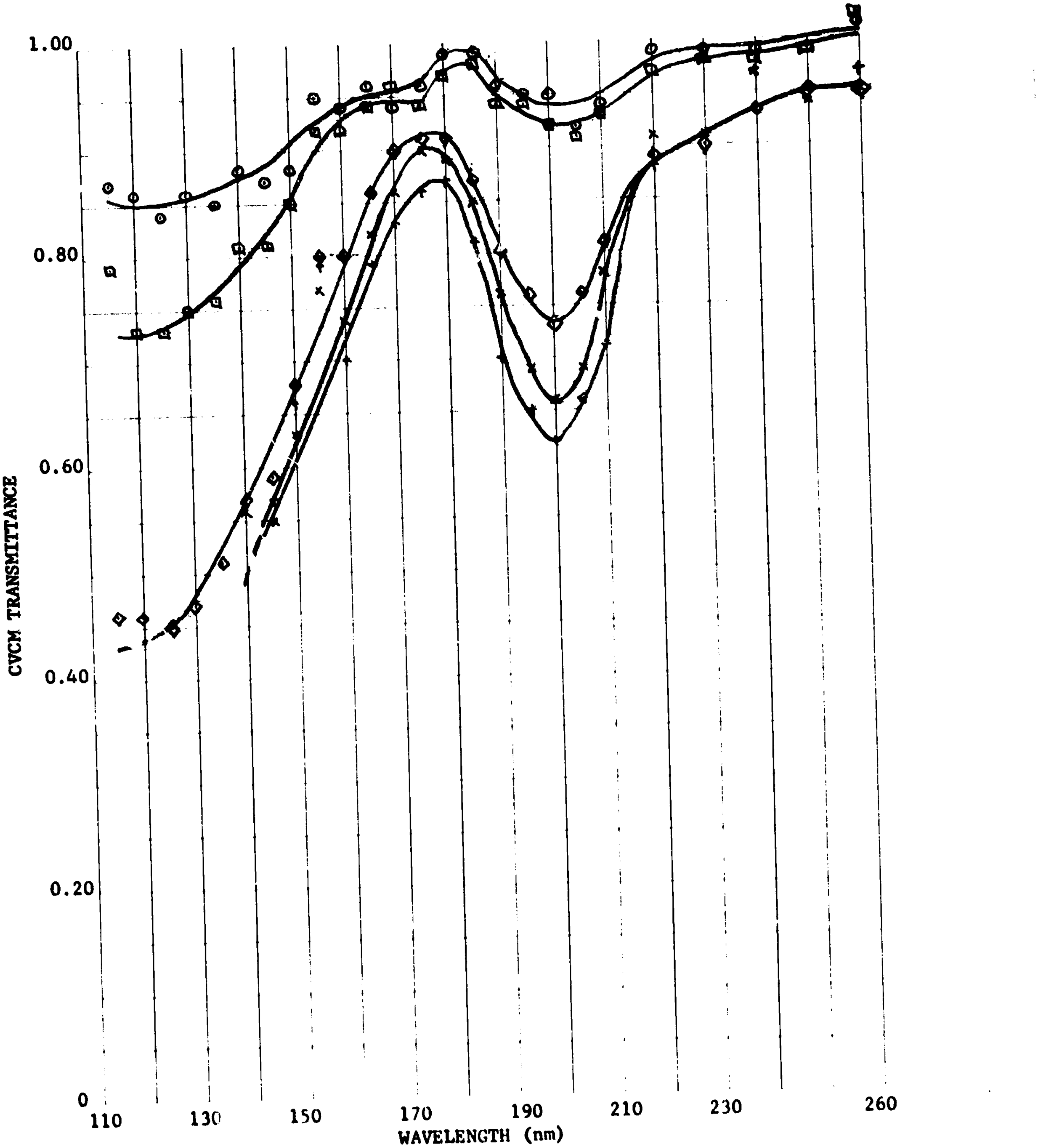

Figure 51. CVCM Transmittance Versus Wavelength, Source Material 3M Nextel 401-C10/901-P1, JPL#144-VOD-2, CVCM Thickness In Angstroms ⊙ 45, ◻ 67, ◇ 198, × 273, + 327.

Table LXV. CVCM Transmittance Versus Wavelength, Source Material 3M Nextel 401-C10/901-P1, JPL #144-VOD-2, Source Temperature 52°C, MgF_2 Window Temperature -75°C, Chamber Pressure 2×10^{-6} Torr.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5
115	0.81	0.87	0.69	0.79	0.23	0.46	0.15	--	0.12	--
120	0.80	0.86	0.63	0.73	0.23	0.46	0.11	--	0.09	--
125	0.78	0.84	0.63	0.73	0.22	0.45	0.12	--	0.07	--
130	0.80	0.86	0.65	0.75	0.24	0.47	0.14	--	0.08	--
135	0.79	0.85	0.66	0.76	0.28	0.51	0.16	--	0.10	--
140	0.82	0.88	0.71	0.81	0.34	0.57	0.22	0.56	0.15	--
145	0.84	0.87	0.74	0.81	0.42	0.59	0.27	0.55	0.19	0.57
150	0.85	0.88	0.78	0.85	0.51	0.68	0.35	0.63	0.28	0.66
155	0.92	0.95	0.85	0.92	0.63	0.80	0.49	0.77	0.41	0.79
160	0.93	0.94	0.89	0.92	0.70	0.80	0.60	0.74	0.51	0.70
165	0.95	0.96	0.91	0.94	0.76	0.86	0.68	0.82	0.60	0.79
170	0.93	0.94	0.93	0.96	0.80	0.90	0.72	0.86	0.64	0.83
175	0.95	0.96	0.91	0.94	0.81	0.91	0.76	0.90	0.67	0.86
180	0.98	0.99	0.94	0.97	0.81	0.91	0.75	0.89	0.68	0.87
185	0.98	0.99	0.95	0.98	0.77	0.87	0.71	0.85	0.62	0.81
190	0.95	0.96	0.91	0.94	0.70	0.80	0.62	0.76	0.51	0.70
195	0.94	0.95	0.91	0.94	0.66	0.76	0.55	0.69	0.46	0.65
200	0.94	0.95	0.89	0.92	0.63	0.73	0.52	0.66	0.42	0.62
205	0.91	0.92	0.88	0.91	0.66	0.76	0.55	0.69	0.47	0.66
210	0.94	0.94	0.93	0.93	0.77	0.81	0.70	0.78	0.61	0.71
220	0.99	0.99	0.97	0.97	0.85	0.89	0.83	0.91	0.78	0.88
230	0.99	0.99	0.98	0.98	0.86	0.90	0.83	0.91	0.81	0.91
240	0.99	0.99	0.98	0.98	0.89	0.93	0.89	0.97	0.87	0.97
250	0.99	0.99	0.99	0.99	0.95	0.95	0.94	0.94	0.95	0.95
260	1.02	1.02	1.03	1.03	0.95	0.95	0.95	0.95	0.97	0.97
270	1.02	1.02	1.02	1.02	0.95	0.95	0.95	0.95	0.95	0.95
280	1.00	1.00	1.03	1.03	0.96	0.96	0.96	0.96	0.95	0.95
290	0.97	0.97	1.02	1.02	0.94	0.94	0.95	0.95	0.96	0.96
300	1.01	1.01	1.03	1.03	0.96	0.96	0.98	0.98	0.97	0.97
CVCM THICKNESS (A)	45		67		198		273		327	
TIME AFTER 100% SCAN (min)	118		276		1318		2741		4188	

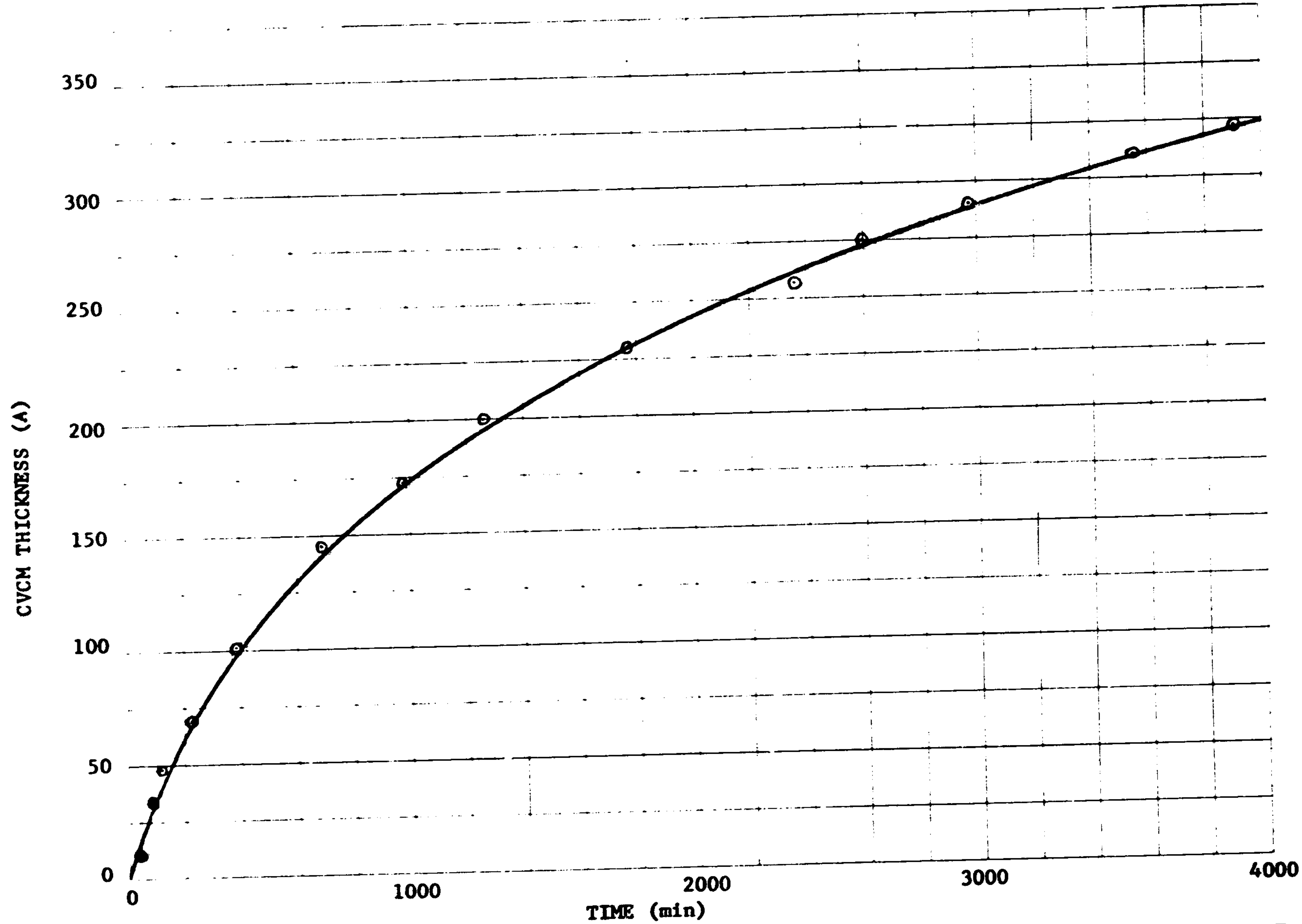

Figure 52. CVCM Thickness In Angstroms Source Material 3M Nextel 401C10/901-P1, JPL#144-VOD-2, Source Temperature 52°C, TQCM Temperature -82°C, TQCM Sensitivity 1.56×10^{-9} g·cm^{-2}.Hz^{-1}, CVCM Specific Gravity Assumed To Be 1.0.

GY70/FIBERITE 934 HELD ON ALUMINUM SUBSTRATE BY SPOT BOND WITH 3M-415 DOUBLE SIDE TAPE

JPL#53B-VOD-1

WEIGHT: GY70/FIBERITE 934 13.6205 g
3M-415 0.1266 g

CURE: AS RECEIVED

SOURCE TEMPERATURE: 53°C

WINDOW TEMPERATURE: -79°C

TQCM TEMPERATURE: -82°C

COMMENTS: RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm

WARMED TO -40°C, NO EFFECT IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 1.10 @ 120 nm
T = 1.00 @ 300 nm

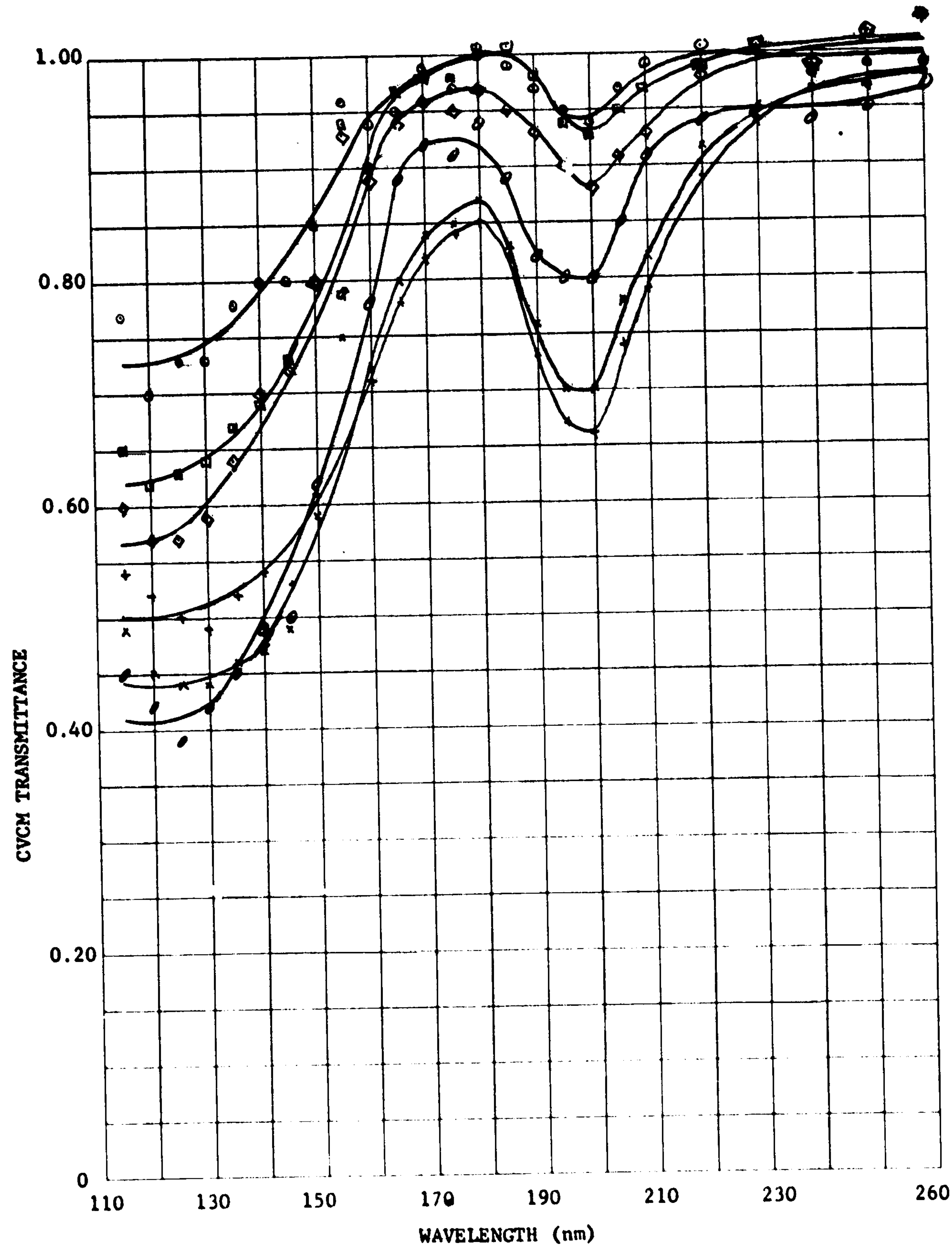

Figure 53. CVCM Transmittance Versus Wavelength, Source Material GY70/Fiberite 934/Spotbound 3M-415 Double Side Tape, JPL#53B-VOD-1, CVCM Thickness In Angstroms ⊙ 61, ◻ 88, ◇ 103, ⌀ 235, × 322, + 370.

Table LXVI. CVCM Transmittance Versus Wavelength, Source Material GY70/Fiberite 934 Spotbond Adhesive 3M#415 Double Side Tape, JPL#53B-VOD-1, Source Temperature 53°C, MgF_2 Window Temperature -79°C, Chamber Pressure $3x10^{-6}$ Torr.

WAVELENGTH (nm)	CVCM TRANSMITTANCE T	T_1	T	T_2	T	T_3	T	T_4	T	T_5	T	T_6
115	0.72	0.77	0.55	0.65	0.48	0.60	0.21	0.45	0.14	0.49	0.10	0.54
120	0.65	0.70	0.52	0.62	0.45	0.57	0.18	0.42	0.10	0.45	0.08	0.52
125	0.68	0.73	0.53	0.63	0.45	0.57	0.15	0.39	0.09	0.44	0.06	0.50
130	0.68	0.73	0.54	0.64	0.47	0.59	0.18	0.42	0.09	0.44	0.05	0.49
135	0.73	0.78	0.57	0.67	0.52	0.64	0.21	0.45	0.11	0.46	0.08	0.52
140	0.75	0.80	0.59	0.69	0.58	0.70	0.25	0.49	0.15	0.47	0.10	0.54
145	0.77	0.80	0.66	0.73	0.64	0.72	0.32	0.50	0.20	0.49	0.15	0.53
150	0.82	0.85	0.73	0.80	0.72	0.80	0.44	0.62	0.30	0.59	0.23	0.61
155	0.93	0.96	0.87	0.94	0.85	0.93	0.61	0.79	0.46	0.75	0.41	0.79
160	0.93	0.94	0.86	0.90	0.86	0.89	0.70	0.78	0.57	0.72	0.52	0.71
165	0.94	0.95	0.93	0.97	0.91	0.94	0.79	0.89	0.65	0.80	0.59	0.78
170	0.98	0.99	0.94	0.98	0.93	0.96	0.82	0.92	0.69	0.84	0.63	0.82
175	0.96	0.97	0.94	0.98	0.92	0.95	0.81	0.91	0.70	0.85	0.65	0.84
180	0.99	1.00	0.97	1.01	0.94	0.97	0.84	0.94	0.72	0.87	0.66	0.85
185	0.98	0.99	0.97	1.01	0.92	0.95	0.79	0.89	0.68	0.83	0.63	0.82
190	0.96	0.97	0.94	0.98	0.90	0.93	0.72	0.82	0.61	0.76	0.54	0.73
195	0.94	0.95	0.90	0.94	0.87	0.90	0.70	0.80	0.55	0.70	0.48	0.67
200	0.93	0.94	0.89	0.93	0.85	0.88	0.70	0.80	0.55	0.70	0.47	0.66
205	0.96	0.97	0.91	0.95	0.88	0.91	0.75	0.85	0.63	0.78	0.55	0.74
210	0.99	0.99	0.97	0.97	0.93	0.93	0.86	0.91	0.75	0.82	0.69	0.79
220	1.01	1.01	0.99	0.99	0.98	0.98	0.89	0.94	0.85	0.92	0.79	0.89
230	1.01	1.01	1.01	1.01	1.01	1.01	0.90	0.95	0.87	0.94	0.84	0.94
240	0.98	0.98	0.99	0.99	0.99	0.99	0.89	0.94	0.90	0.97	0.88	0.98
250	0.99	0.99	1.02	1.02	1.03	1.03	0.95	0.95	0.97	0.97	0.97	0.97
260	0.99	0.99	1.04	1.04	1.04	1.04	0.97	0.97	0.98	0.98	0.99	0.99
270	1.02	1.02	1.06	1.06	1.06	1.06	0.97	0.97	0.98	0.98	1.01	1.01
280	1.02	1.02	1.04	1.04	1.06	1.06	0.95	0.95	0.97	0.97	0.99	0.99
290	1.03	1.03	1.06	1.06	1.05	1.05	0.97	0.97	0.99	0.99	1.01	1.01
300	1.00	1.00	1.05	1.05	1.04	1.04	0.98	0.98	1.01	1.01	1.01	1.01
CVCM THICKNESS (A)	61		88		103		235		322		370	
TIME AFTER 100% SCAN (min)	103		268		402		1445		2868		4274	

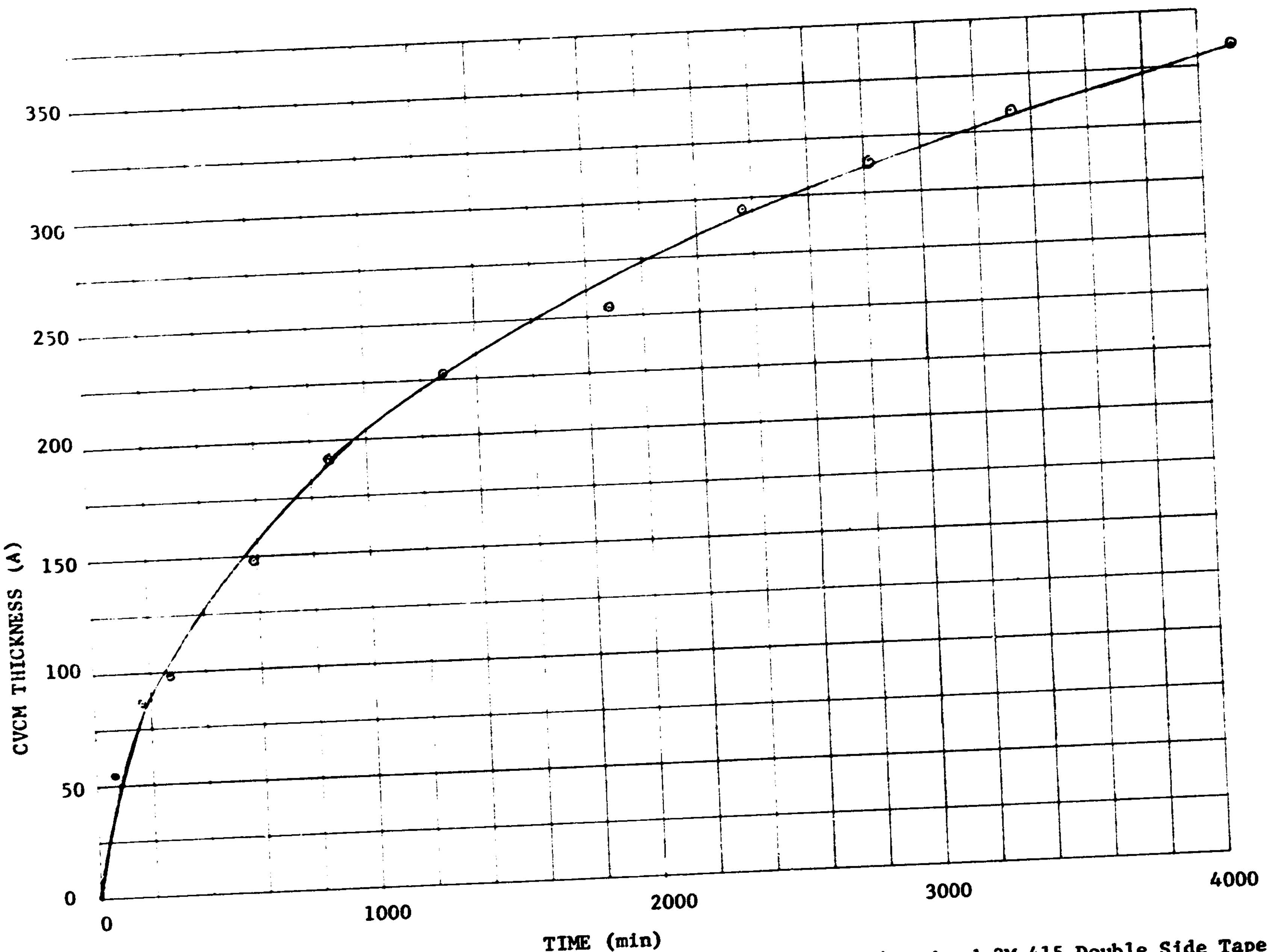

Figure 54. CVCM Thickness In Angstroms, Source Material GY70/Fiberite 934/Spotbond 3M-415 Double Side Tape, JPL# 53B-VOD-1, Source Temperature 53°C, TQCM Temperature -82°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

SOLITHANE 113/C113-300, FORMULATION 8

JPL#12A-VOD-2

WEIGHT: 1.0574 g

CURE: 24 HR @ AMBIENT; AMBIENT PRESSURE

SOURCE TEMPERATURE: 52°C

WINDOW TEMPERATURE: -78°C

TQCM TEMPERATURE: -82°C

COMMENTS: STRONG ABSORPTION NEAR 195 nm

WARMED TO -40°C, NO EFFECT IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMTERATURE T = 1.08 @ 120 nm
T = 0.98 @ 300 nm

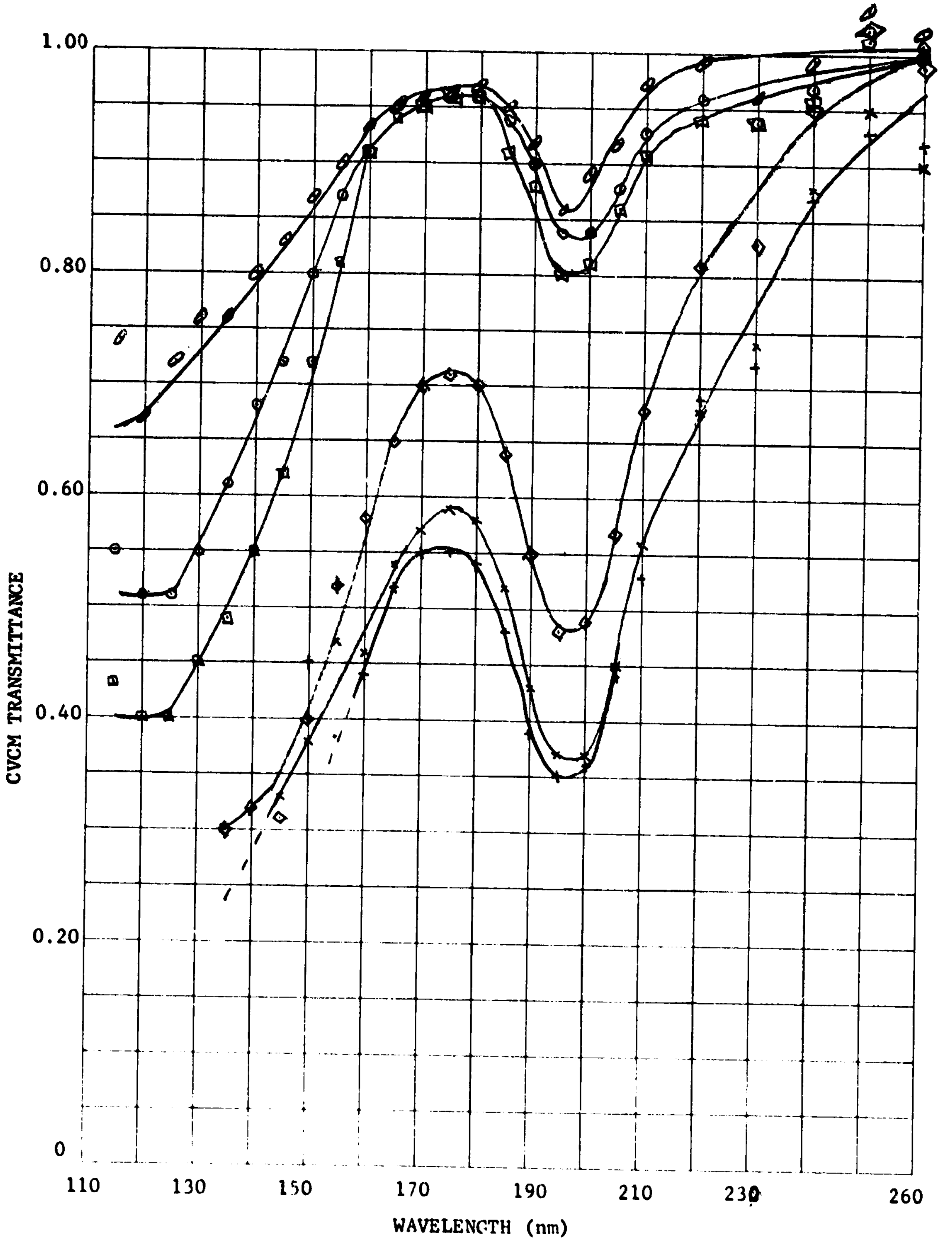

Figure 55. CVCM Transmittance Versus Wavelength, Source Material Solithane 113/C113-300, JPL#12A-VOD-2, CVCM Thickness In Angstroms ⌀ 69, ○ 132, □ 191, ◇ 607, × 936, + 1131.

Table LXVII. CVCM Transmittance Versus Wavelength, Source Material Solithane 113/C113-300, JPL #12A-VOD-2, Source Temperature 52°C, MgF_2 Window Temperature -78°C, Chamber Pressure $2x10^{-6}$ Torr.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5	T	T_6
115	0.69	0.74	0.45	0.55	0.31	0.43	0.07	--	0.00	--	0.00	--
120	0.62	0.67	0.41	0.51	0.28	0.40	0.05	--	0.00	--	0.00	--
125	0.67	0.72	0.41	0.51	0.28	0.40	0.00	--	0.00	--	0.00	--
130	0.71	0.76	0.45	0.55	0.33	0.45	0.05	--	0.00	--	0.00	--
135	0.71	0.76	0.51	0.61	0.37	0.49	0.06	0.30	0.00	--	0.00	--
140	0.75	0.80	0.58	0.68	0.43	0.55	0.08	0.32	0.03	--	0.00	--
145	0.80	0.83	0.65	0.72	0.54	0.62	0.13	0.31	0.05	0.33	0.00	--
150	0.84	0.87	0.73	0.80	0.64	0.72	0.22	0.40	0.10	0.38	0.07	0.45
155	0.87	0.90	0.80	0.87	0.73	0.81	0.34	0.52	0.19	0.47	0.14	0.52
160	0.92	0.93	0.88	0.91	0.86	0.91	0.48	0.58	0.31	0.46	0.25	0.44
165	0.94	0.95	0.92	0.95	0.89	0.94	0.55	0.65	0.39	0.54	0.33	0.52
170	0.95	0.96	0.92	0.95	0.90	0.95	0.60	0.70	0.41	0.56	0.36	0.55
175	0.95	0.96	0.93	0.96	0.91	0.96	0.61	0.71	0.44	0.59	0.36	0.55
180	0.96	0.97	0.93	0.96	0.91	0.96	0.60	0.70	0.43	0.58	0.35	0.54
185	0.94	0.95	0.91	0.94	0.86	0.91	0.54	0.64	0.37	0.52	0.29	0.48
190	0.91	0.92	0.87	0.90	0.83	0.88	0.45	0.55	0.28	0.43	0.20	0.39
195	0.85	0.86	0.81	0.84	0.75	0.80	0.38	0.48	0.22	0.37	0.16	0.35
200	0.88	0.89	0.81	0.84	0.76	0.81	0.39	0.49	0.22	0.37	0.17	0.36
205	0.91	0.92	0.85	0.88	0.81	0.86	0.47	0.57	0.30	0.45	0.25	0.44
210	0.97	0.97	0.93	0.93	0.91	0.91	0.63	0.68	0.48	0.56	0.43	0.53
220	0.99	0.99	0.96	0.96	0.94	0.94	0.76	0.81	0.60	0.68	0.59	0.69
230	0.96	0.96	0.94	0.94	0.94	0.94	0.78	0.83	0.66	0.74	0.62	0.72
240	0.99	0.99	0.97	0.97	0.96	0.96	0.90	0.95	0.80	0.88	0.77	0.87
250	1.04	1.04	1.03	1.03	1.02	1.02	1.03	1.03	0.95	0.95	0.93	0.93
260	1.02	1.02	1.01	1.01	1.00	1.00	0.99	0.99	0.90	0.90	0.92	0.92
270	1.04	1.04	1.03	1.03	1.01	1.01	1.02	1.02	0.93	0.93	0.97	0.97
280	1.05	1.05	1.02	1.02	1.02	1.02	1.02	1.02	0.95	0.95	0.94	0.94
290	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	0.97	0.97	0.98	0.98
300	1.02	1.02	1.05	1.05	1.03	1.03	1.05	1.05	0.99	0.99	0.99	0.99
CVCM THICKNESS (A)	69		132		191		607		936		1131	
TIME AFTER 100% SCAN (min)	72		256		379		1396		2828		4244	

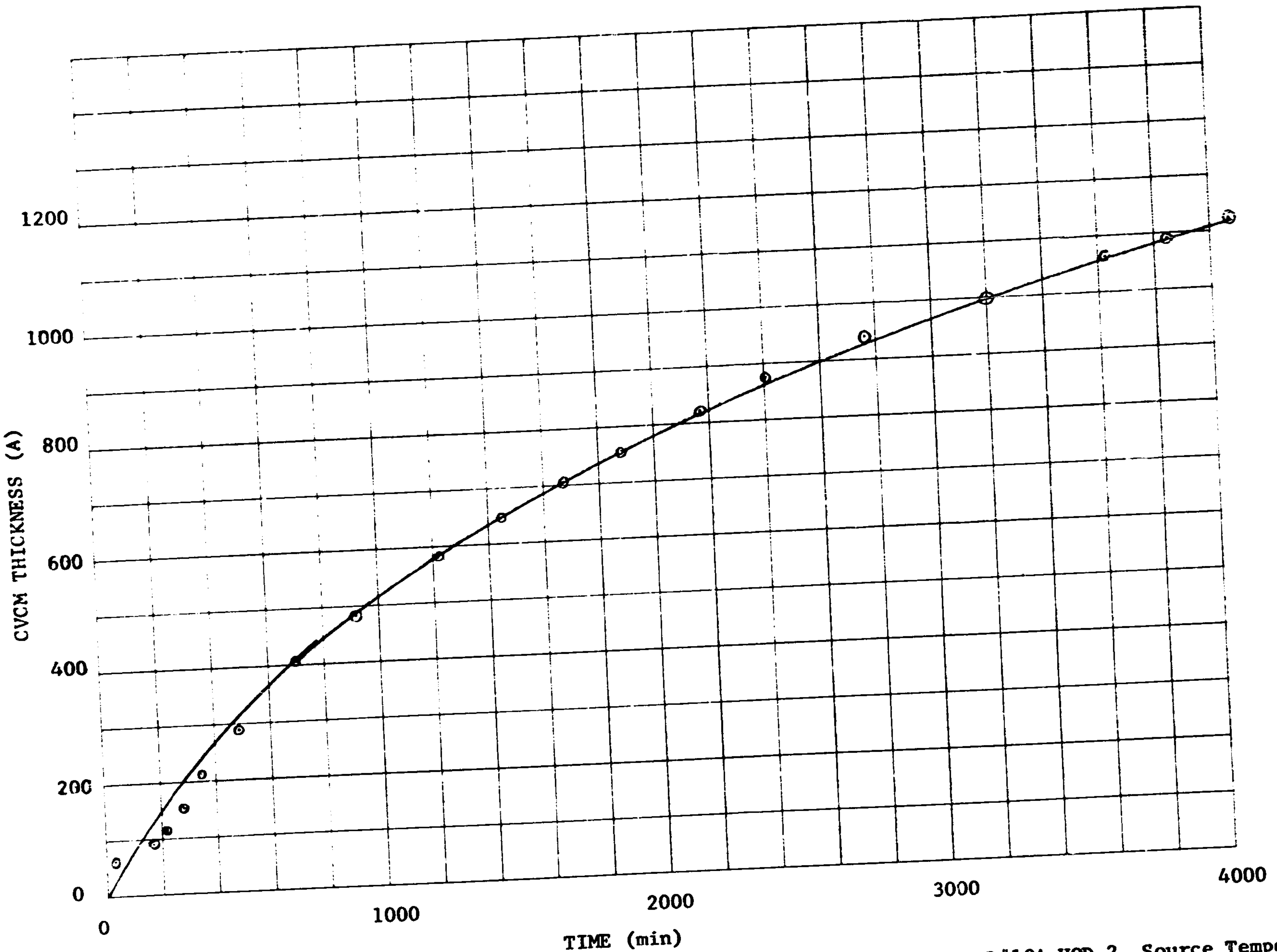

Figure 56. CVCM Thickness In Angstroms, Source Material Solithane 113/C113-300, JPL#12A-VOD-2, Source Temperature 52°C, TQCM Temperature -82°C, TQCM Sensitivity $1.56x10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

SOLITHANE 113/C113-300, FORMULATION 8

JPL#12A-VOD-3

WEIGHT: 1.5589 g

CURE: 24 HR @ AMBIENT; AMBIENT PRESSURE
16 HR @ 130°F; VACUUM

SOURCE TEMPERATURE: 50°C

WINDOW TEMPERATURE: -78°C

TQCM TEMPERATURE: -82°C

COMMENTS: SLIGHT DECREASE IN CVCM DEPOSITION DUE TO VACUUM BAKE

STRONG ABSORPTION NEAR 200 nm

WARMED TO -40°C, NO AFFECT IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 1.28 @ 120 nm
T = 0.94 @ 300 nm

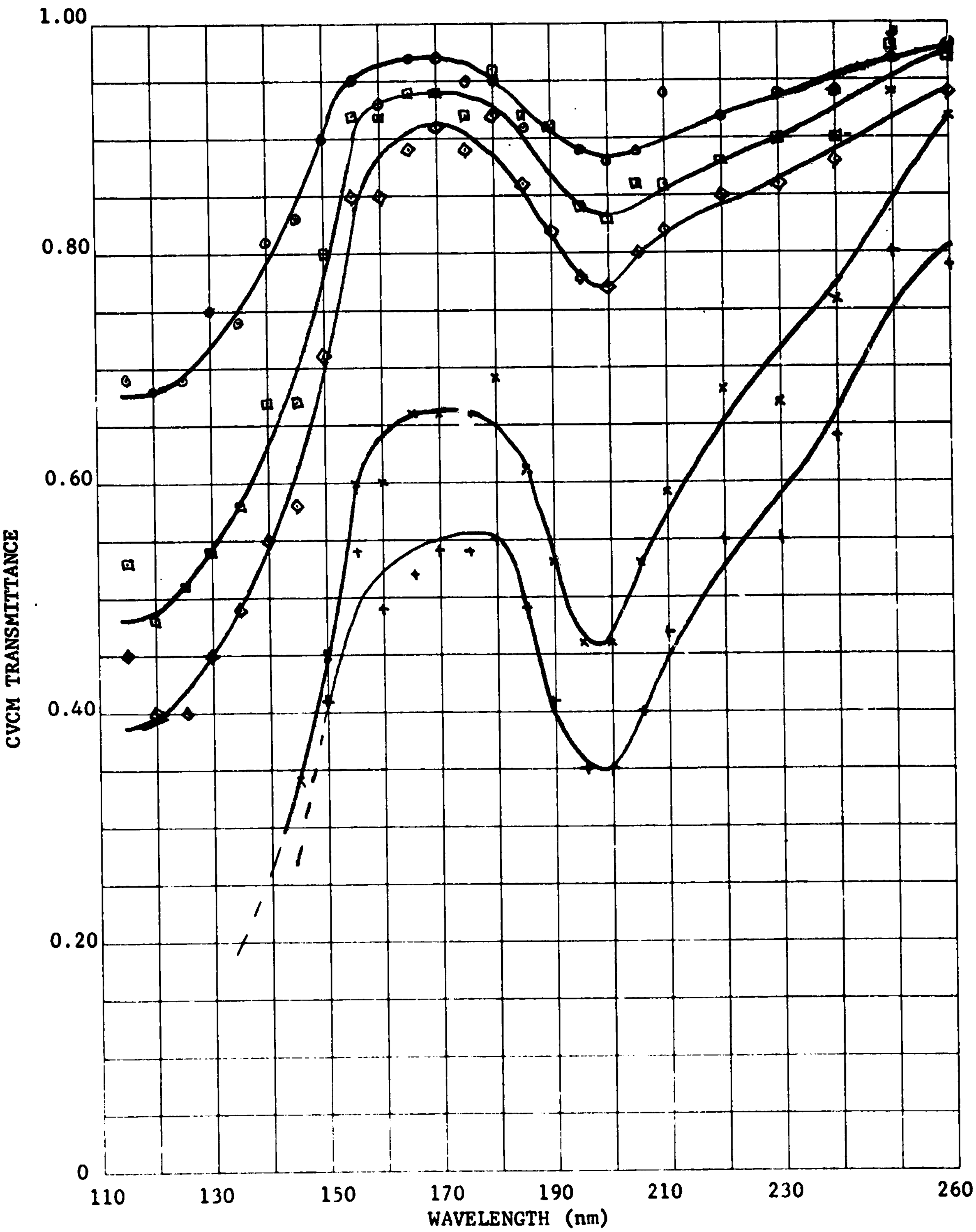

Figure 57. CVCM Transmittance Versus Wavelength, Source Material Solithane 113/C113-300, JPL#12A-VOD-3, CVCM Thickness In Angstroms ⊙67, ⊡104, ◇149, × 456, + 749.

Table LXVIII. CVCM Transmittance Versus Wavelength, Source Material Solithane 113/C113-300, JPL #12A-VOD-3, Source Temperature 50°C, MgF_2 Window Temperature -78°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5
115	0.63	0.69	0.43	0.53	0.33	0.45	0.10	--	0.07	--
120	0.62	0.68	0.38	0.48	0.28	0.40	0.08	--	0.05	--
125	0.63	0.69	0.41	0.51	0.28	0.40	0.07	--	0.02	--
130	0.69	0.75	0.44	0.54	0.33	0.45	0.06	--	0.04	--
135	0.68	0.74	0.48	0.58	0.37	0.49	0.08	--	0.03	--
140	0.75	0.81	0.57	0.67	0.43	0.55	0.10	--	0.04	--
145	0.80	0.83	0.61	0.67	0.50	0.58	0.16	0.34	0.06	--
150	0.87	0.90	0.74	0.80	0.63	0.71	0.27	0.45	0.13	0.41
155	0.92	0.95	0.86	0.92	0.77	0.85	0.42	0.60	0.26	0.54
160	0.92	0.93	0.89	0.92	0.81	0.85	0.50	0.60	0.35	0.49
165	0.96	0.97	0.91	0.94	0.85	0.89	0.56	0.66	0.38	0.52
170	0.96	0.97	0.91	0.94	0.87	0.91	0.56	0.66	0.40	0.54
175	0.94	0.95	0.89	0.92	0.85	0.89	0.56	0.66	0.40	0.54
180	0.94	0.95	0.93	0.96	0.88	0.92	0.59	0.69	0.41	0.55
185	0.90	0.91	0.89	0.92	0.82	0.86	0.51	0.61	0.35	0.49
190	0.90	0.91	0.88	0.91	0.78	0.82	0.43	0.53	0.27	0.41
195	0.88	0.89	0.81	0.84	0.74	0.78	0.36	0.46	0.21	0.35
200	0.87	0.88	0.80	0.83	0.73	0.77	0.36	0.46	0.21	0.35
205	0.88	0.89	0.83	0.86	0.76	0.80	0.43	0.53	0.26	0.40
210	0.94	0.94	0.86	0.86	0.82	0.82	0.54	0.59	0.39	0.47
220	0.92	0.92	0.88	0.88	0.85	0.85	0.63	0.68	0.47	0.55
230	0.94	0.94	0.90	0.90	0.86	0.86	0.62	0.67	0.47	0.55
240	0.94	0.94	0.90	0.90	0.88	0.88	0.71	0.76	0.56	0.64
250	0.99	0.99	0.98	0.98	0.97	0.97	0.94	0.94	0.80	0.80
260	0.98	0.98	0.97	0.97	0.94	0.94	0.92	0.92	0.79	0.79
270	1.03	1.03	0.98	0.98	0.96	0.96	0.95	0.95	0.85	0.85
280	1.01	1.01	0.98	0.98	0.98	0.98	0.95	0.95	0.88	0.88
290	0.98	0.98	0.97	0.97	0.98	0.98	0.97	0.97	0.90	0.90
300	1.05	1.05	1.00	1.00	0.98	0.98	0.99	0.99	0.96	0.96
CVCM THICKNESS (A)	67		104		149		456		749	
TIME AFTER 100% SCAN (min)	99		251		379		1374		2811	

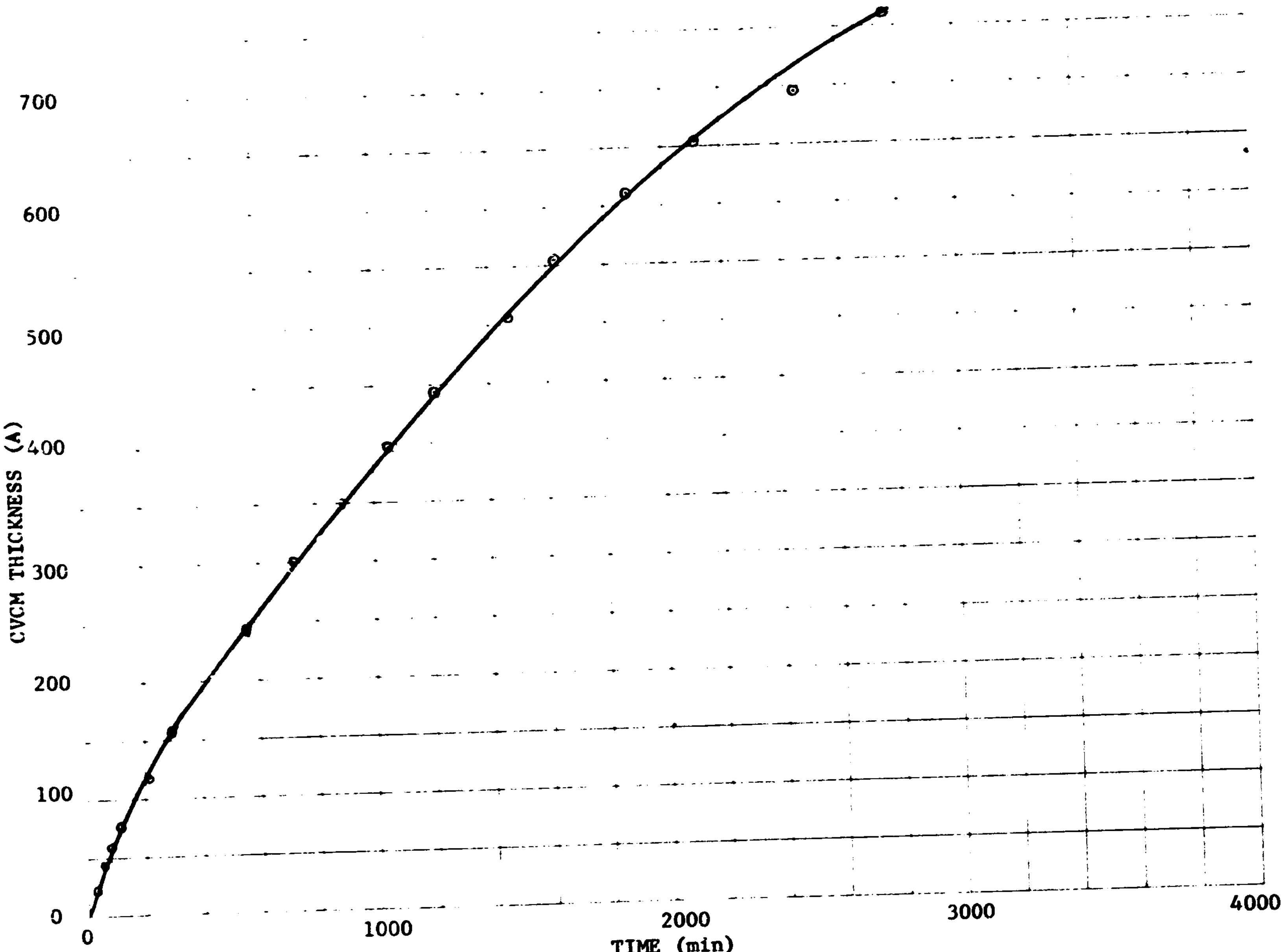

Figure 58. CVCM Thickness Versus Time, Source Material Solithane 113/C113-300, JPL#12A-VOD-3, Source Temperature $50^{o}C$, TQCM Sensitivity 1.56×10^{-9} $g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0, TQCM $-32^{o}C$.

SOLITHANE 113/C113-300, FORMULATION 1 WITHOUT T-12

JPL#12B-VOD-1

WEIGHT: 0.7313 g

CURE: 24 HR @ AMBIENT; AMBIENT PRESSURE

SOURCE TEMPERATURE: 51°C

WINDOW TEMPERATURE: -77°C

TQCM TEMPERATURE: -82°C

COMMENTS: STRONG ABSORPTION NEAR 200 nm

CVCM DEPOSITION FOR FORMULATION 8 SAME AS FORMULATION 1

WARMED TO -39°C, NO AFFECT ON TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 1.28 @ 120 nm

T = 0.98 @ 300 nm

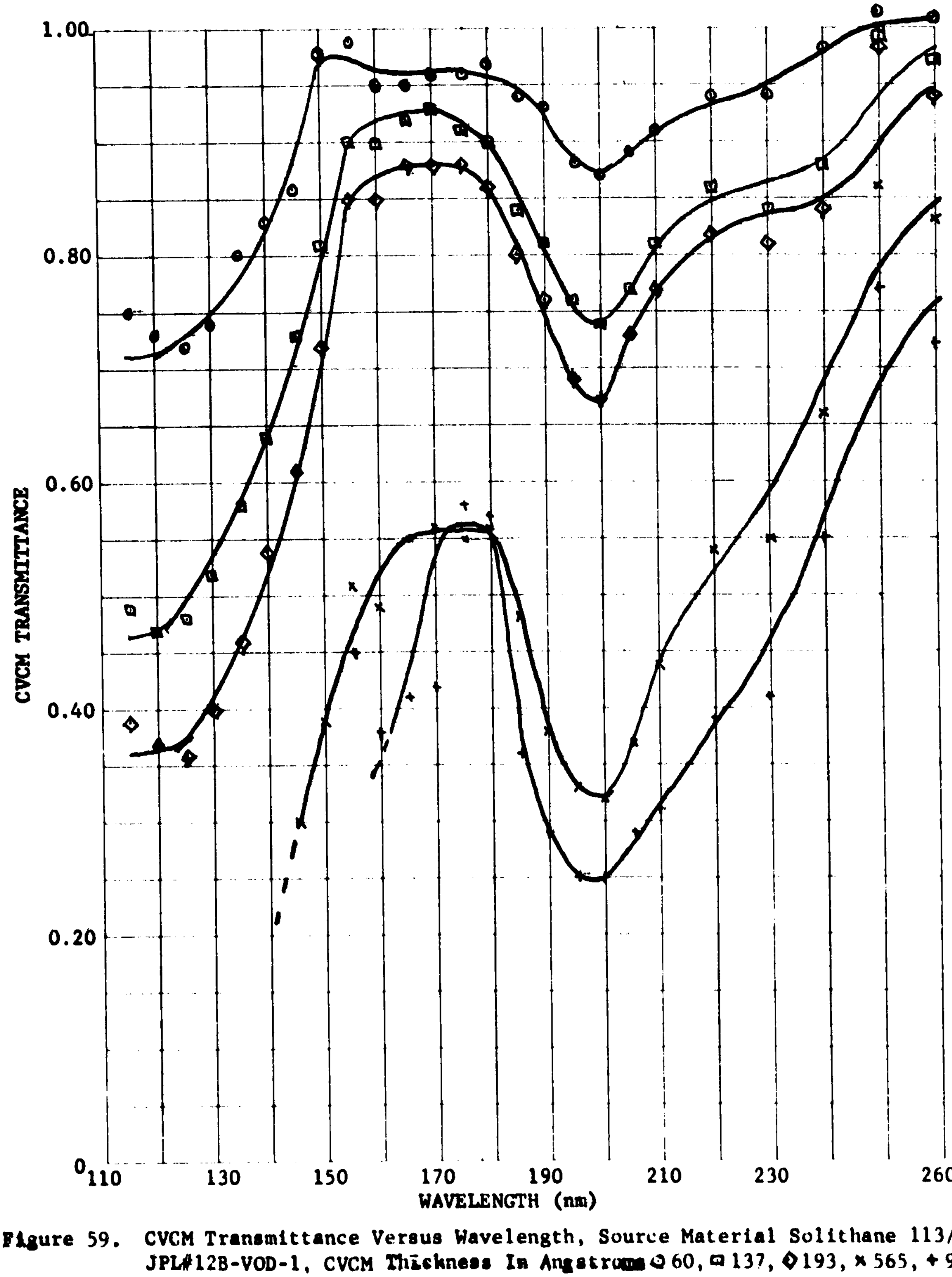

Figure 59. CVCM Transmittance Versus Wavelength, Source Material Solithane 113/C113-300, JPL#12B-VOD-1, CVCM Thickness In Angstroms ○ 60, □ 137, ◇ 193, × 565, + 992.

Table LXIX. CVCM Transmittance Versus Wavelength, Source Material Solithane 113/C113-300, JPL #128-VOD-1, Source Temperature 51°C, MgF_2 Window Temperature -77°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5
115	0.70	0.75	0.40	0.49	0.27	0.39	0.10	--	0.10	--
120	0.68	0.73	0.38	0.47	0.25	0.37	0.08	--	0.05	--
125	0.67	0.72	0.39	0.48	0.24	0.36	0.04	--	0.04	--
130	0.69	0.74	0.43	0.52	0.28	0.40	0.03	--	0.03	--
135	0.75	0.80	0.49	0.58	0.34	0.46	0.05	--	0.03	--
140	0.78	0.83	0.55	0.64	0.42	0.54	0.08	--	0.03	--
145	0.83	0.86	0.67	0.73	0.52	0.61	0.12	0.30	0.04	--
150	0.95	0.98	0.75	0.81	0.63	0.72	0.21	0.39	0.08	--
155	0.96	0.99	0.84	0.90	0.76	0.85	0.33	0.51	0.16	0.45
160	0.94	0.95	0.87	0.90	0.81	0.85	0.39	0.49	0.23	0.38
165	0.94	0.95	0.89	0.92	0.84	0.88	0.45	0.55	0.26	0.41
170	0.95	0.96	0.90	0.93	0.84	0.88	0.46	0.56	0.27	0.42
175	0.95	0.96	0.88	0.91	0.84	0.88	0.45	0.55	0.43	0.58
180	0.96	0.97	0.87	0.90	0.82	0.86	0.46	0.56	0.42	0.57
185	0.93	0.94	0.81	0.84	0.76	0.80	0.38	0.48	0.21	0.36
190	0.92	0.93	0.78	0.81	0.72	0.76	0.28	0.38	0.14	0.29
195	0.87	0.88	0.73	0.76	0.65	0.69	0.23	0.33	0.10	0.25
200	0.86	0.87	0.71	0.74	0.63	0.67	0.22	0.32	0.10	0.25
205	0.88	0.89	0.74	0.77	0.69	0.73	0.27	0.37	0.14	0.29
210	0.91	0.91	0.81	0.81	0.77	0.77	0.39	0.44	0.23	0.31
220	0.94	0.94	0.86	0.86	0.82	0.82	0.49	0.54	0.31	0.39
230	0.94	0.94	0.84	0.84	0.81	0.81	0.50	0.55	0.33	0.41
240	0.98	0.98	0.88	0.88	0.84	0.84	0.61	0.66	0.47	0.55
250	1.02	1.02	0.99	0.99	0.98	0.98	0.86	0.86	0.77	0.77
260	1.01	1.01	0.97	0.97	0.94	0.94	0.83	0.83	0.72	0.72
270	1.01	1.01	0.99	0.99	0.96	0.96	0.90	0.90	0.80	0.80
280	1.05	1.05	1.01	1.01	1.01	1.01	0.98	0.98	0.87	0.87
290	1.03	1.03	1.03	1.03	0.99	0.99	0.99	0.99	0.89	0.89
300	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.90	0.90
CVCM THICKNESS (A)	60		137		193		565		992	
TIME AFTER 100% SCAN (min)	88		235		388		1476		2914	

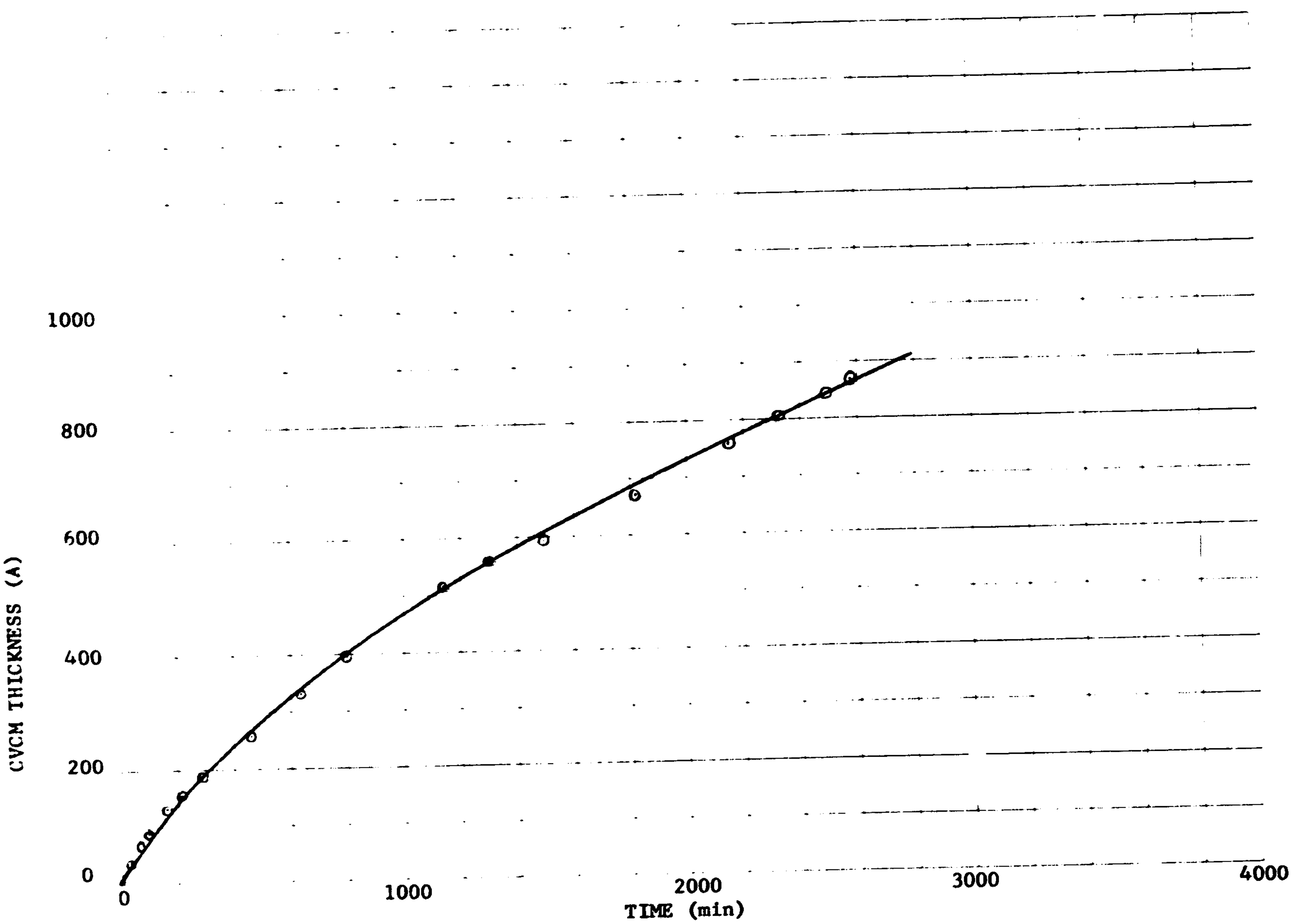

Figure 60. CVCM Thickness In Angstroms Versus Time, Source Material Solithane 113/C113-300, JPL#12B-VOD-1, Source Temperature 51°C, TQCM Temperature -82°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} . Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

LUBE-LOK 4306

JPL#135-VOD-1

WEIGHT: 0.4198 g

CURE: AIR DRY, 4 HR @ 300°F; AMBIENT PRESSURE

SOURCE TEMPERATURE: 52°C

WINDOW TEMPERATURE: -73°C

TQCM TEMPERATURE: -82°C

COMMENTS: RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm
AFTER TEST, AMBIENT TEMPERATURE, T = 1.16 @ 120 nm
T = 0.89 @ 300 nm

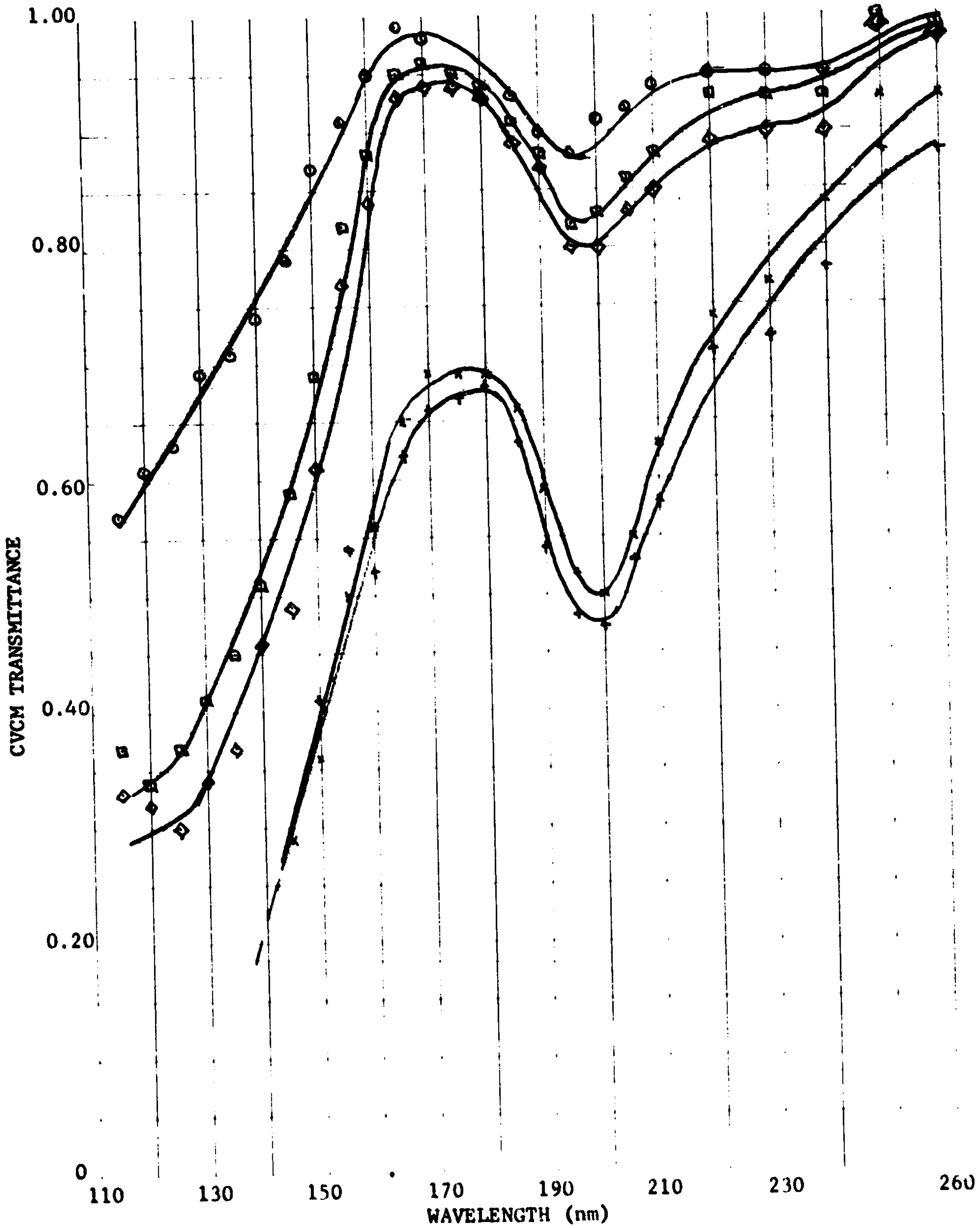

Figure 61. CVCM Transmittance Versus Wavelength, Source Material Lube-Lok 4306, JPL# 135-VOD-1, CVCM Thickness In Angstroms ⊙ 91, ⊡ 164, ◇ 194, × 340, + 424.

Table LXX. CVCM Transmittance Versus Wavelength, Source Material Lube-Lok 4306, JPL # 135-VOD-1, Source Temperature 52°C, MgF_2 Window Temperature -73°C, Chamber Pressure $2x10^{-6}$ Torr.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5
115	0.53	0.57	0.27	0.37	0.20	0.33	0.07	--	0.07	--
120	0.57	0.61	0.24	0.34	0.19	0.32	0.05	--	0.05	--
125	0.59	0.63	0.27	0.37	0.17	0.30	0.05	--	0.02	--
130	0.65	0.69	0.31	0.41	0.21	0.34	0.04	--	0.02	--
135	0.67	0.71	0.35	0.45	0.24	0.37	0.04	--	0.02	--
140	0.70	0.74	0.41	0.51	0.30	0.46	0.07	--	0.03	--
145	0.77	0.79	0.53	0.59	0.40	0.49	0.11	0.29	0.06	--
150	0.85	0.87	0.63	0.69	0.52	0.61	0.18	0.36	0.12	0.41
155	0.89	0.91	0.76	0.82	0.68	0.77	0.32	0.50	0.25	0.54
160	0.94	0.95	0.85	0.88	0.79	0.84	0.46	0.56	0.37	0.52
165	0.98	0.99	0.92	0.95	0.88	0.93	0.55	0.65	0.47	0.62
170	0.97	0.98	0.93	0.96	0.89	0.94	0.59	0.69	0.51	0.66
175	0.93	0.94	0.92	0.95	0.89	0.94	0.59	0.69	0.52	0.67
180	0.92	0.93	0.91	0.94	0.88	0.93	0.59	0.69	0.53	0.68
185	0.92	0.93	0.88	0.91	0.84	0.89	0.56	0.66	0.48	0.63
190	0.89	0.90	0.85	0.88	0.82	0.87	0.49	0.59	0.39	0.54
195	0.87	0.88	0.79	0.82	0.75	0.80	0.42	0.52	0.33	0.48
200	0.90	0.91	0.80	0.83	0.75	0.80	0.40	0.50	0.32	0.47
205	0.91	0.92	0.83	0.86	0.78	0.83	0.45	0.55	0.38	0.53
210	0.94	0.94	0.88	0.88	0.85	0.85	0.58	0.63	0.50	0.58
220	0.95	0.95	0.93	0.93	0.89	0.89	0.69	0.74	0.63	0.71
230	0.95	0.95	0.93	0.93	0.90	0.90	0.72	0.77	0.64	0.72
240	0.95	0.95	0.93	0.93	0.90	0.90	0.79	0.84	0.70	0.78
250	0.99	0.99	1.00	1.00	0.99	0.99	0.93	0.93	0.88	0.88
260	0.98	0.98	0.99	0.99	0.98	0.98	0.93	0.93	0.88	0.88
270	0.99	0.99	1.02	1.02	1.01	1.01	0.96	0.96	0.94	0.94
280	1.00	1.00	1.02	1.02	1.01	1.01	0.97	0.97	0.92	0.92
290	1.01	1.01	1.01	1.01	1.01	1.01	0.99	0.99	0.96	0.96
300	1.02	1.02	1.00	1.00	1.02	1.02	1.01	1.01	0.99	0.99
CVCM THICKNESS (A)	91		164		194		340		424	
TIME AFTER 100% SCAN (min)	58		249		412		1421		2878	

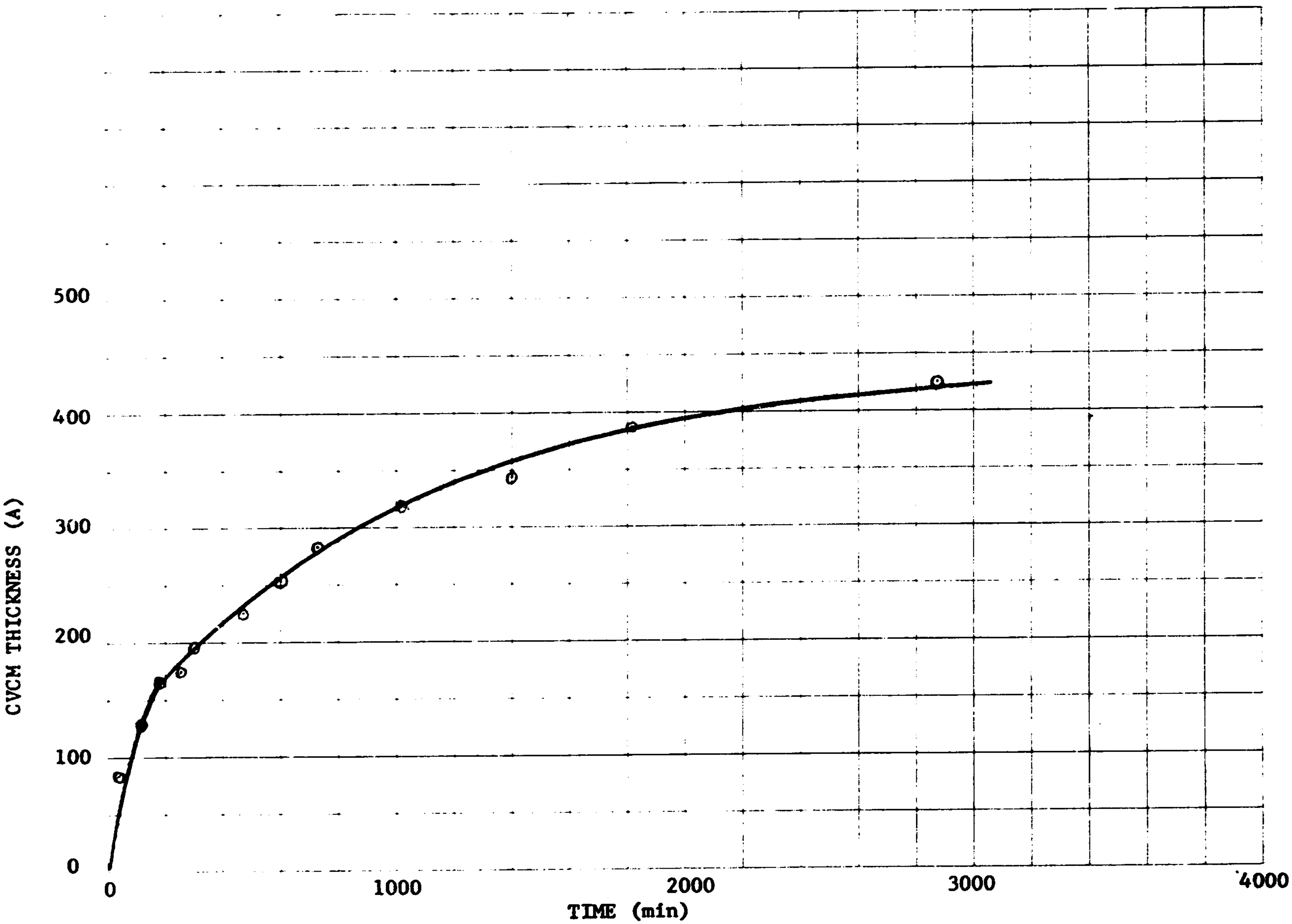

Figure 62. CVCM Thickness In Angstroms Versus Time, Source Material Lube-Lok 4306, JPL#135-VOD-1, Source Temperature 52°C, TQCM Temperature -82°C, TQCM Sensitivity $1.56 \times 10^{-9} g \cdot cm^{-2} \cdot Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

RT/DUROID 5813, SPOT BONDED WITH 3M-415 DOUBLE SIDE TAPE

JPL#91-VOD-1

WEIGHT: RT/DUROID 5813 4.4103 g
3M-415 0.1164 g

CURE: AS RECEIVED

SOURCE TEMPERATURE: 49°C

WINDOW TEMPERATURE: -77°C

TQCM TEMPERATURE: -82°C

COMMENTS: RELATIVE MINIMUM IN TRANSMITTANCE NEAR 200 nm

WARMED TO -40°C, NO AFFECT IN TRANSMITTANCE

AFTER TEST, AMBIENT TEMPERATURE, T = 1.16 @ 120 nm
T = 0.96 @ 300 nm

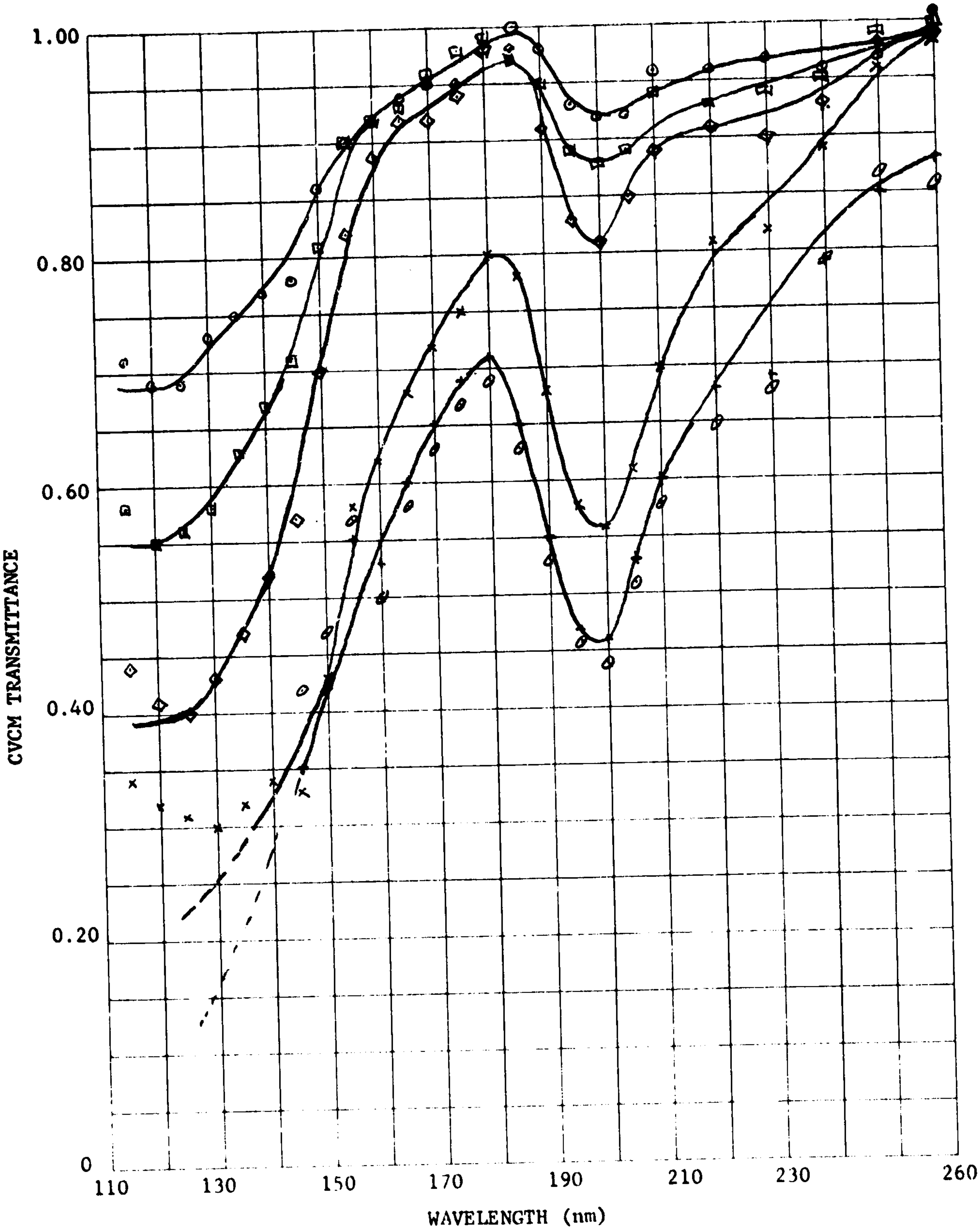

Figure 63. CVCM Transmittance Versus Wavelength, Source Material RT/Duroid, JPL# 91-VOD-I, CVCM Thickness In Angstroms O 40, □ 59, ◇ 87, × 212, + 325, ⌀ 382.

Table LXXI. CVCM Transmittance Versus Wavelength, Source Material RT/Duroid, JPL#91-VOD-1, Source Temperature 49°C, MgF_2 Window Temperature -77°C.

WAVELENGTH (nm)	T	T_1	T	T_2	T	T_3	T	T_4	T	T_5	T	T_6
115	0.65	0.71	0.48	0.58	0.32	0.44	0.10	(0.34)	0.06	--	0.06	--
120	0.63	0.69	0.45	0.55	0.29	0.41	0.08	(0.32)	0.05	--	0.05	--
125	0.63	0.69	0.46	0.56	0.28	0.40	0.07	(0.31)	0.04	--	0.02	--
130	0.67	0.73	0.48	0.58	0.31	0.43	0.06	(0.30)	0.04	--	0.02	--
135	0.69	0.75	0.53	0.63	0.35	0.47	0.08	0.32	0.03	--	0.02	--
140	0.71	0.77	0.57	0.67	0.40	0.52	0.10	0.34	0.04	--	0.01	--
145	0.75	0.78	0.65	0.71	0.49	0.57	0.15	0.33	0.06	0.35	0.04	0.42
150	0.83	0.86	0.75	0.81	0.62	0.70	0.25	0.43	0.13	0.42	0.09	0.47
155	0.87	0.90	0.84	0.90	0.74	0.82	0.40	0.58	0.26	0.55	0.19	0.57
160	0.91	0.92	0.89	0.92	0.84	0.89	0.52	0.62	0.38	0.53	0.31	0.50
165	0.93	0.94	0.90	0.93	0.87	0.92	0.58	0.68	0.45	0.60	0.39	0.58
170	0.94	0.95	0.93	0.96	0.87	0.92	0.62	0.72	0.50	0.65	0.44	0.63
175	0.94	0.95	0.95	0.98	0.89	0.94	0.65	0.75	0.54	0.69	0.48	0.67
180	0.97	0.98	0.96	0.99	0.93	0.98	0.70	0.80	0.56	0.71	0.50	0.69
185	0.99	1.00	0.94	0.97	0.93	0.98	0.67	0.77	0.50	0.65	0.44	0.63
190	0.97	0.98	0.92	0.95	0.86	0.91	0.58	0.68	0.40	0.55	0.34	0.53
195	0.92	0.93	0.86	0.89	0.78	0.83	0.48	0.58	0.32	0.47	0.27	0.46
200	0.91	0.92	0.85	0.88	0.76	0.81	0.46	0.56	0.31	0.46	0.25	0.44
205	0.91	0.92	0.86	0.89	0.80	0.85	0.51	0.61	0.38	0.53	0.32	0.51
210	0.96	0.96	0.94	0.94	0.89	0.89	0.65	0.70	0.52	0.60	0.48	0.58
220	0.96	0.96	0.93	0.93	0.91	0.91	0.76	0.81	0.60	0.68	0.55	0.65
230	0.97	0.97	0.94	0.94	0.90	0.90	0.77	0.82	0.61	0.69	0.58	0.68
240	0.96	0.96	0.95	0.95	0.93	0.93	0.84	0.89	0.71	0.79	0.69	0.79
250	0.97	0.97	0.99	0.99	0.98	0.98	0.96	0.96	0.85	0.85	0.87	0.87
260	1.01	1.01	1.00	1.00	0.99	0.99	0.98	0.98	0.88	0.88	0.86	0.86
270	1.03	1.03	1.02	1.02	0.99	0.99	0.97	0.97	0.90	0.90	0.88	0.88
280	1.04	1.04	1.01	1.01	1.01	1.01	0.99	0.99	0.92	0.92	0.90	0.90
290	1.05	1.05	1.05	1.05	0.99	0.99	1.03	1.03	0.97	0.97	0.94	0.94
300	1.03	1.03	1.02	1.02	0.99	0.99	0.99	0.99	0.97	0.97	0.95	0.95
CVCM THICKNESS (A)	40		59		87		212		325		382	
TIME AFTER 100% SCAN (min)	101		235		383		1450		2879		4279	

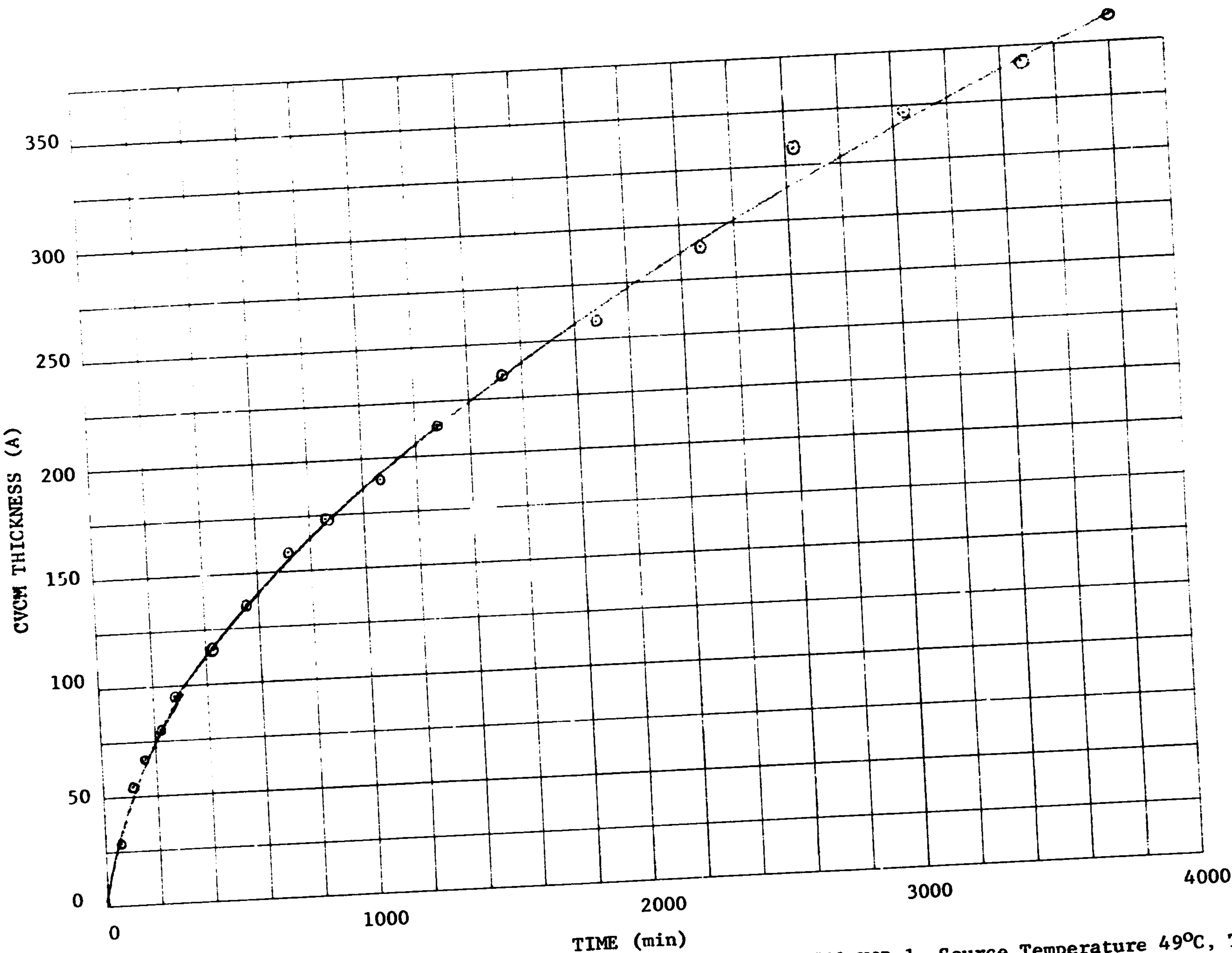

Figure 64. CVCM Thickness In Angstroms, Source Material RT/Duroid, JPL#91-VOD-1, Source Temperature 49°C, TQCM Temperature -82°C, TQCM Sensitivity $1.56 \times 10^{-9} g.cm^{-2}.Hz^{-1}$, CVCM Specific Gravity Assumed To Be 1.0.

3.4 CVCM Reemission Tests And Results

After the transmittance tests, the temperature of the TQCM crystal was increased to 101°C to obtain the reemission parameters of ten selected material CVCM. Figure 65 shows a typical sigmodal thermogravimetric mass loss, in this case for the CVCM from Ablebond 36-2. Similar to source outgassing, first order reemission kinetics are applied to the CVCM mass loss data. The deposited contaminants can have rate constants different from the parent material. Because the parent material can have several major molecular species, each of which are released in varying degrees at any temperature, the resulting CVCM will be different since it is produced by a parent material temperature of about 50°C. The term active material, a_o, has to be qualified for the reemission tests since the temperature of the TQCM crystal can only be raised to 101°C and the test is stopped at that point. In general, all of the CVCM is reemitted by the time the crystal reached 101°C. Any residual CVCM would probably be reemitted at this temperature if the test would continue for some reasonable period. Table LXXII presents the reemission parameters for the ten CVCMs. The percent of active CVCM is labeled a_e' to highlight its limitation. The TQCM frequency output was normalized for its unique crystal pair temperature effect.

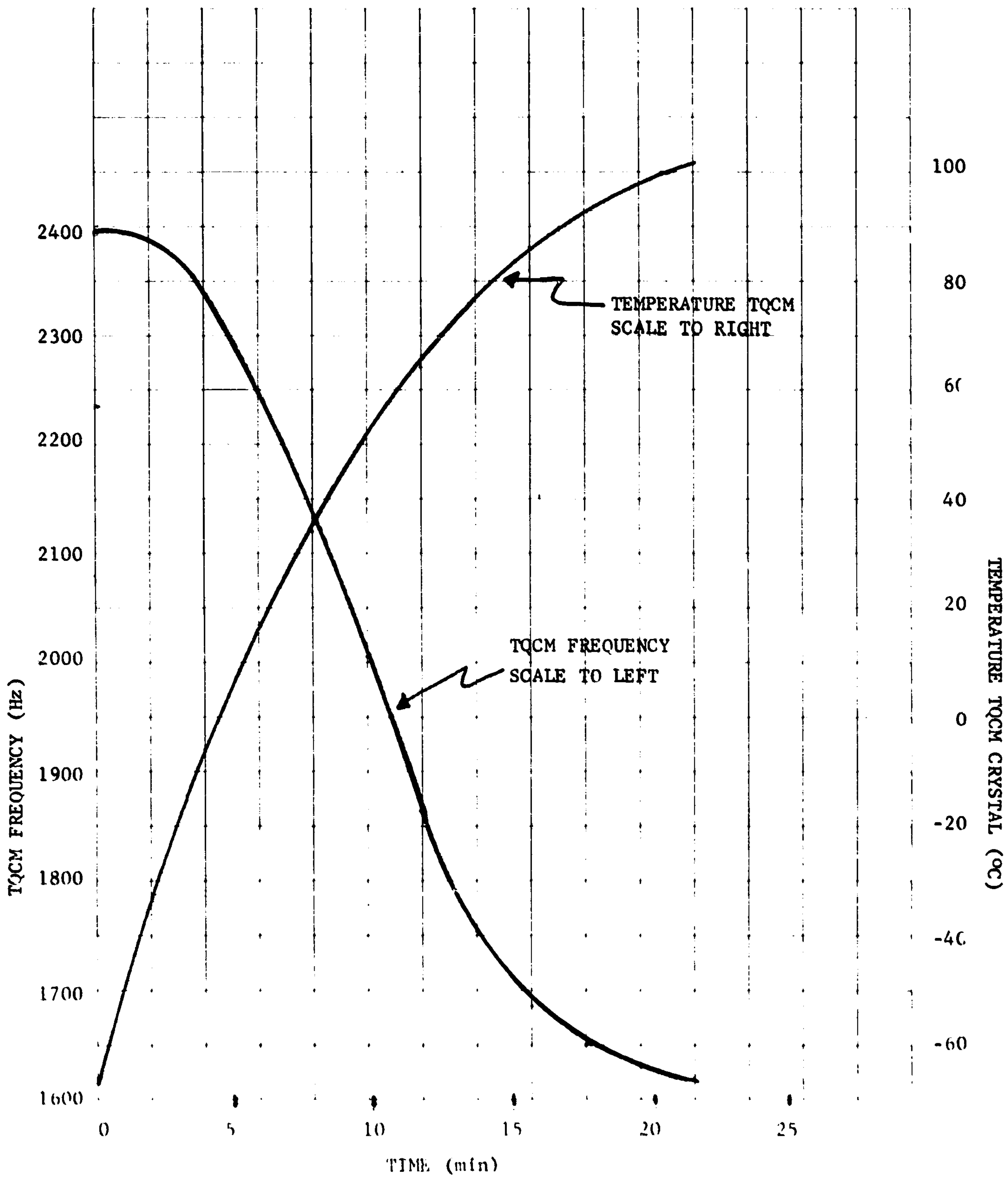

Figure 65. Reemission Of CVCM From Ablebond 36-2 Versus Time. Temperature Of TQCM Crystal Versus Time.

Table LXXII. CVCM Reemission Parameters.

MATERIAL	E_1 (cal·mole^{-1})	A_1 (min^{-1})	a'_{e1} (%)	E_2 (cal·mole^{-1})	A_2 (min^{-1})	a'_{e2} (%)
Ablebond 36-2	2,430	0.64	100	--	--	--
EA 9309 Ambient Cure	43,500	5.59×10^{29}	100	--	--	--
Scotch-Weld Ambient Cure	12,300	1.10×10^{10}	34	55,500	1.50×10^{34}	66
3M-415	35,200	6.60×10^{22}	100	--	--	--
[illegible]-306/9922 131-VOD-1	14,700	2.70×10^{11}	51	18,700	3.50×10^{12}	24
CAT-A-LAC 463-3-8 127-VOD-1	30,700	5.45×10^{22}	100	--	--	--
3M Nextel 401-C10/901-P1 144-VOD-1	7,470	6.38×10^{3}	99	--	--	--
GY70/Fiberite 934 53B-VOD-1	5.780	3.60×10^{3}	93	--	--	--
Lube-Lok 4306 135-VOD-1	8,240	2.24×10^{4}	95	--	--	--
Solithane 113/C113-300 12B-VOD-1	5,330	1.14×10^{3}	95	--	--	--

4.0 CONCLUSIONS AND RECOMMENDATIONS

The source outgassing parameters shown in Table II show a wide range of effective activation energies ranging from 6220 to 42200 cal·mole^{-1}. The percent of active material in each source varied from 66% for Chemglaze Z-306/AP-131 to 0.1% for EA-9309. The RGA data shows that a significant portion (99^{+}%) of the VCM is composed of light molecules that will not condense except at cryogenic temperatures (less than -160°C). The vacuum bake significantly reduces the percent of heavy molecules (above 46 amu) emitted for EA-934, 3M-415, Brand X, and 3M Nextel unprimed. It did not affect Epon 828/871, Scotchweld, Epon 815/Versamed 140, and 3M Nextel 401-C10/901-P1. There is a larger percent of heavy molecules for the primer AP-131 than for 9922. Also for Chemglaze Z-306, the 9922 primer has a lower amount of active material than AP-131 primer. For Cat-A-Lac 463-3-8, the addition of the primer 463-6-5 does not significantly increase the amount of active material. The vacuum bake at 176°F significantly reduced the amount of active material in all cases except for Scotchweld and EA-9309. For the Brand X tape, the vacuum bake removed the first component of the active material to within the sensitivity of the thermogravimetric analyzer.

The isothermal mass loss for MLI showed a linear rate of 5x10^{-5}%·min^{-1} after the initial period. Using the first order rate parameters for MLI from Table II gives a predicted mass loss rate of 3x10^{-5}%·min^{-1} at 1000 min, and 5x10^{-5}%·min^{-1} at 2000 min.

Future work could include repeating the dynamic thermogravimetric tests for 3M Nextel, Fiberite 934, Braycote, and vacuum cured 3M-415 at various initial weights in order to obtain the outgassing parameters for these materials.

Significantly low values of transmittance were found for wavelengths below 230 nm even for thin films of CVCM. For the CVCM of Ablebond 36-2 at a thickness of 48 Å, a transmittance of only 0.64 at Lyman Alpha (122 nm) was recorded. Assuming a linear extrapolation, this means that only a 2 Å thick CVCM would exceed the usual 1% loss in throughput tolerated in space optical instruments. If several surfaces are involved then the allowed CVCM is even less. At a thickness of only 151 Å, the Trabond BB-2116 CVCM was opaque for wavelengths shorter than 160 nm. Baking EA-9309 in vacuum for 24 hr @ 176°F did not remove the CVCM species which is strongly absorbing for wavelengths shorter than 160 nm. The relative change in transmittance for the unbaked EA-9309 is about the same as the baked EA-9309 for the same CVCM thickness. Similar statements can be made for Scotchweld, Chemglaze Z-306 over 9922 primer, Chemglaze Z-306 over AP-131 primer, 3M Nextel 401-C10 over 901-P1 primer, and Solithane 113/C113-300. The data indicates that vacuum temperature conditioning does not affect the loss in transmittance per unit CVCM thickness.

The isothermal CVCM deposition data taken during the VOD tests show that EA-9309 produced the highest deposition. The remaining materials were all grouped together producing less than 400 Å of CVCM during the 4000 min period. Cat-A-Lac 463-3-8 over 463-6-5 primer produced the lowest CVCM, only about 10 Å in the 2.8 day period. Figure 66 presents selected plots of CVCM versus time.

Future work in VOD tests should focus on CVCM transmittance for thicknesses less than 50 Å. Vacuums in the low 10^{-7} Torr range or less should be used to eliminate any background corrections. A RGA in the VOD chamber would be useful to better understand the environment about the deposition substrate. Rather than plot the transmittance of the CVCM, the absorption coefficient would incorporate the thickness parameter. Although, strickly speaking, the absorption coefficient should be determined without exiting the medium (no substrate or cell windows), vacuum uv literature does contain plots of absorption coefficient obtained through cells.[7]

The CVCM reemission parameters are, as expected, different from the parent material. The data indicates that at 50°C, all CVCM would be reemitted within two hours (except for Ablebond, 8 hr). Thus, warming the CCD detector window can significantly remove degrading CVCM.

Future work should complete the analysis of the CVCM reemission data and obtain the reemission parameters for the remaining 18 VOD test materials.

The data in this report can be used to predict levels of WFPC degradation by modeling the instrument for contamination assessment. Using the geometry of the instrument, the predicted thermal profile, the planned orbital parameters, and the planned mission operations; the source outgassing parameters can determine the VCM flux to the window, the transmittance curves can determine the degraded signal, and the reemission parameters to assess resultant thicknesses of CVCM.

K. Dressler and O. Schnepp, Absorption Spectra of Solid Methane, Ammonia, and Ice in the Vacuum Ultraviolet, J.Chem.Phys., 33, July, 1960.

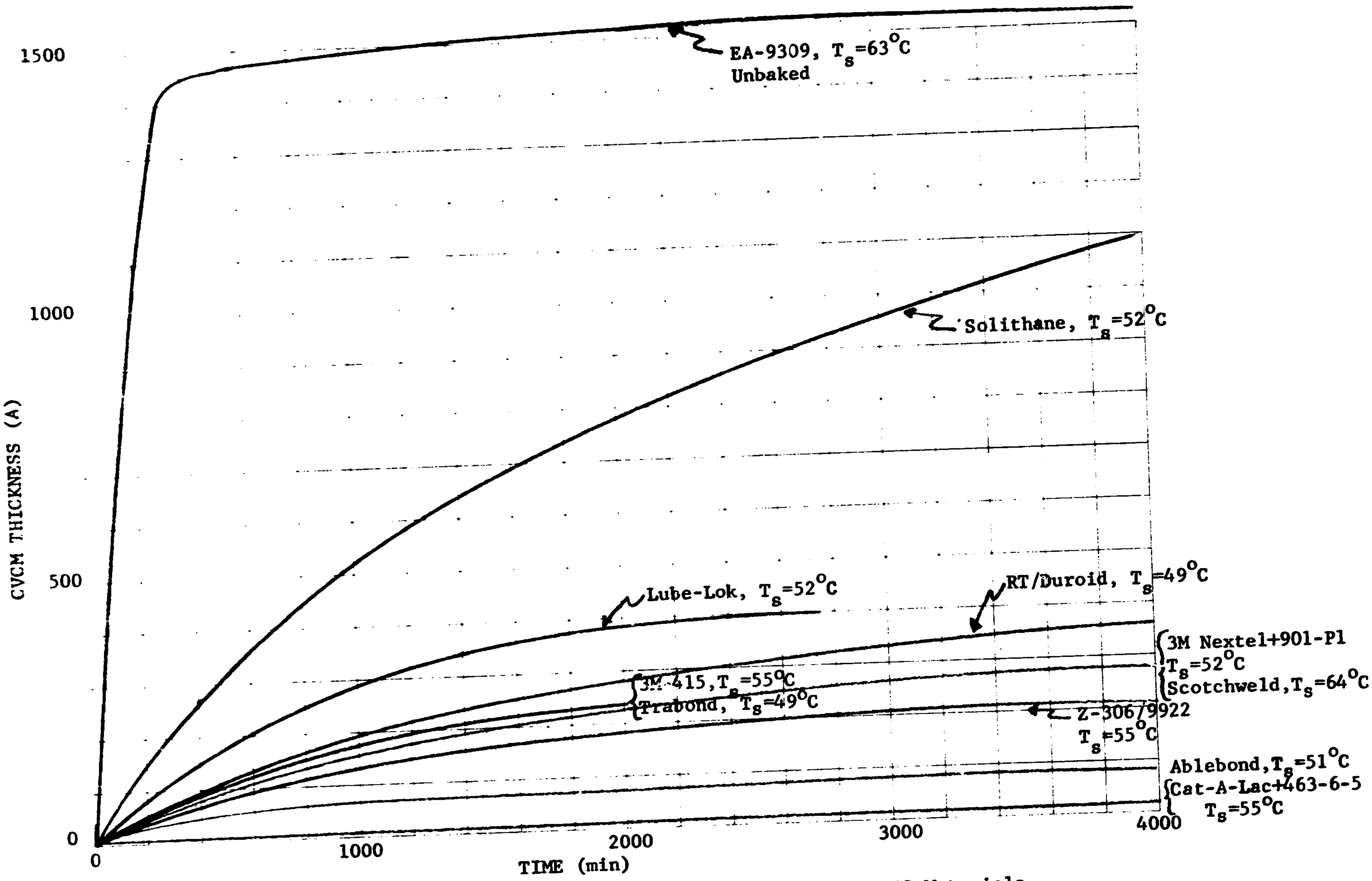

Figure 66. Isothermal CVCM Thickness In Angstroms Versus Time For Selected WFPC Materials.