NASA-CR-199678

COLOR ILLUSTRATIONS
38

INTERIM
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P-40

Interim Report

submitted to

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

October 10, 1995

for Contract NAS8 - 38609

Delivery Order 136

entitled

Space Environment Effects on Thermal Control Coatings

by

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(NASA-CR-199678) SPACE ENVIRONMENT EFFECTS ON THERMAL CONTROL COATINGS Interim Report (Alabama Univ.) 40 p
N96-70327
Unclas
Z9/27 0075845

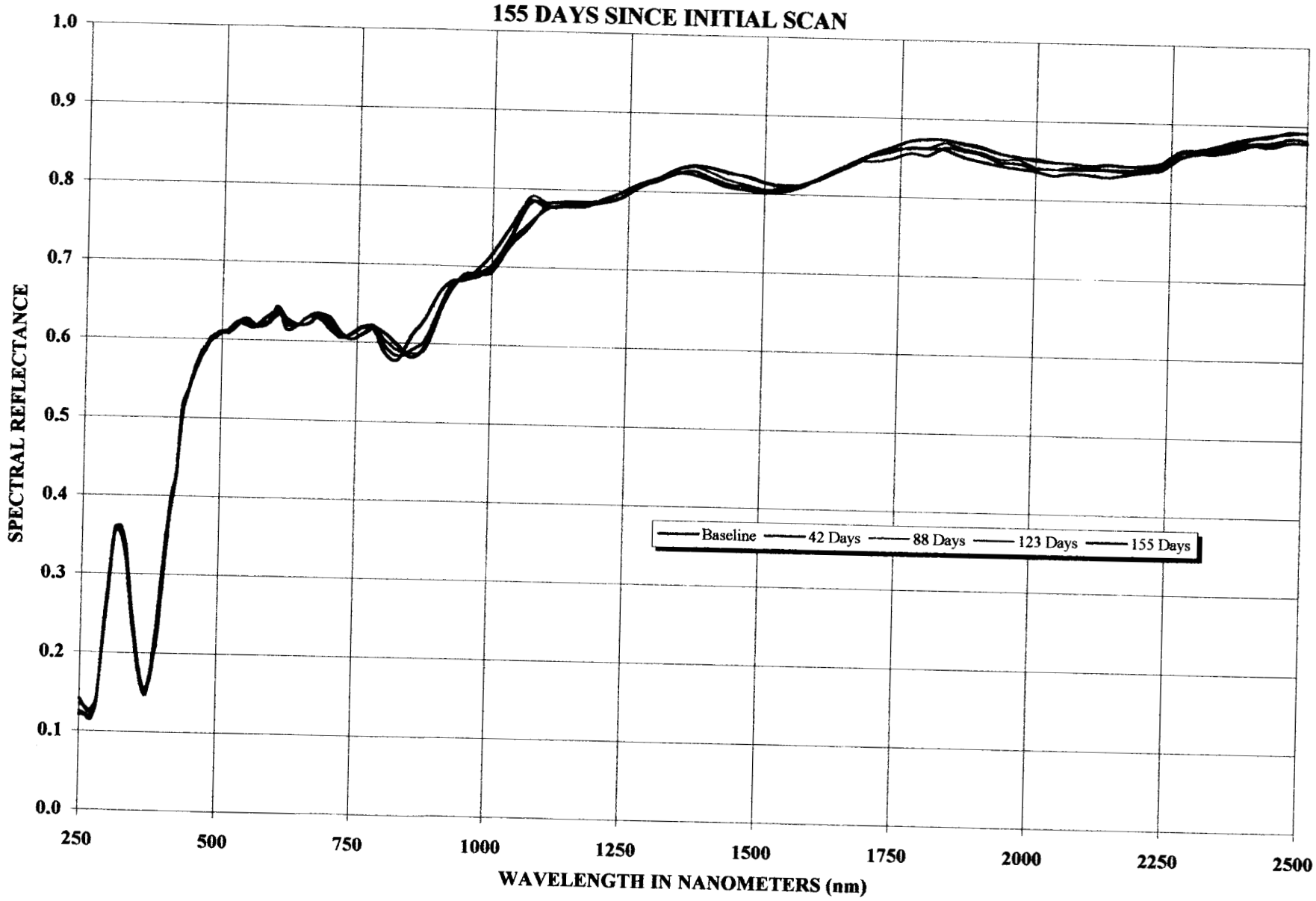
Interim Report for D.O. 136
September 26, 1995

With monitoring of the samples in the UV chamber, this phase of the work has continued. This report includes the accumulative spectral data for this phase of the project.

The latest spectral reflectance scans were taken using the LPSR on September 6, 1995. The samples were exposed for a total of 155 days, with 90 days at 3.05 UV suns and 65 days at 2.89 suns. The change in the amount of solar radiation is due to a change in the UV light source. Spectral scans were made on all test specimen and control specimen. Examining the results from the Z-93 white diffuse paint, change in the spectral reflectance has occurred in all three samples for the ultra-violet region. (These samples include sample #B169-13 which was protected with the quartz window, sample #B169-7 which was protected with a Pyrex window and sample #B169-3 which had no protection.) Likewise, noticeable changes occurred in the visible region for the samples #B169-3 that was not protected with a window and #B169-13 that was protected with a quartz window. Minimal changes occurred in sample #B169-7 in the visible region. The infrared regions showed little to no change in the spectral reflectance for all three Z-93 samples.

All three of the optical witness samples behaved in the same manner with minimal changes across all wavelengths. The chromic anodized aluminum displayed a large change in spectral reflectance across the whole wavelength when comparing the baseline with the first 42 days of exposure at 3.05 UV suns. Minimal change between the first 42 days at 3.05 UV suns and 88 days at 3.05 UV suns. Then moderate change was seen between 88 days at 3.05 UV suns and the fourth scan taken 90 days at 3.05/ 33 days at 2.89 UV suns. No change was seen between the fourth and the fifth scan at 90 days at 3.05 UV 65 days at 2.89 UV suns across the entire measured wavelength. The 2219 aluminum samples saw minimal change over the entire wavelength for all scans Closer examination of the scans can be found in the graphs on the following pages.

CHROMIC ANODIZED ALUMINUM CONTROL SAMPLE II-6C UV EXPOSURE STUDY - LPSR DATA



CAA Control Sample II-6C

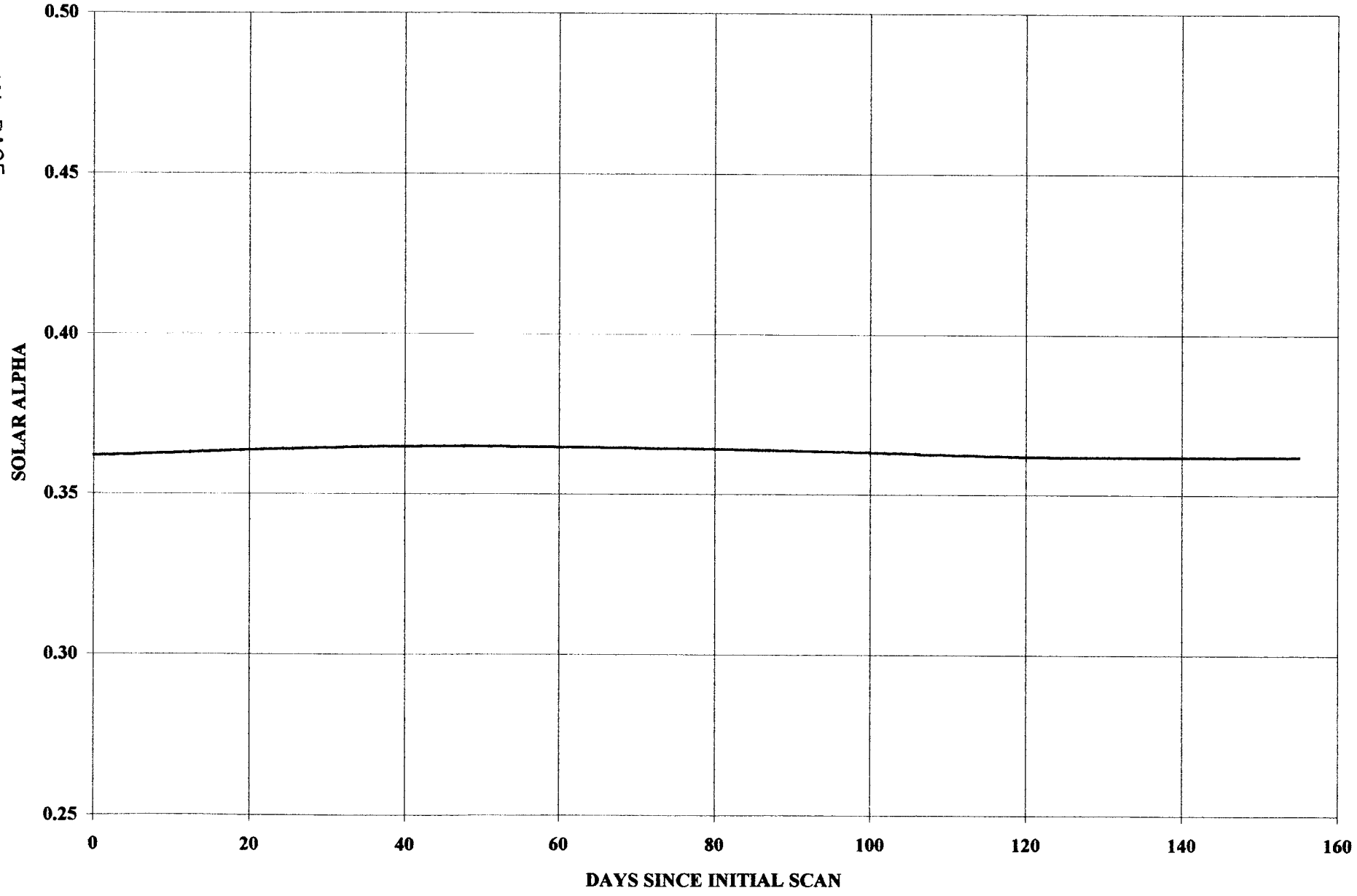
File: CONTROLS.XLS,/
Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

ORIGINAL PAGE
COLOR PHOTOGRAPH

CHANGE IN SOLAR ALPHA FOR CHROMIC ANODIZED ALUMINUM CONTROL

155 DAYS SINCE INITIAL SCAN

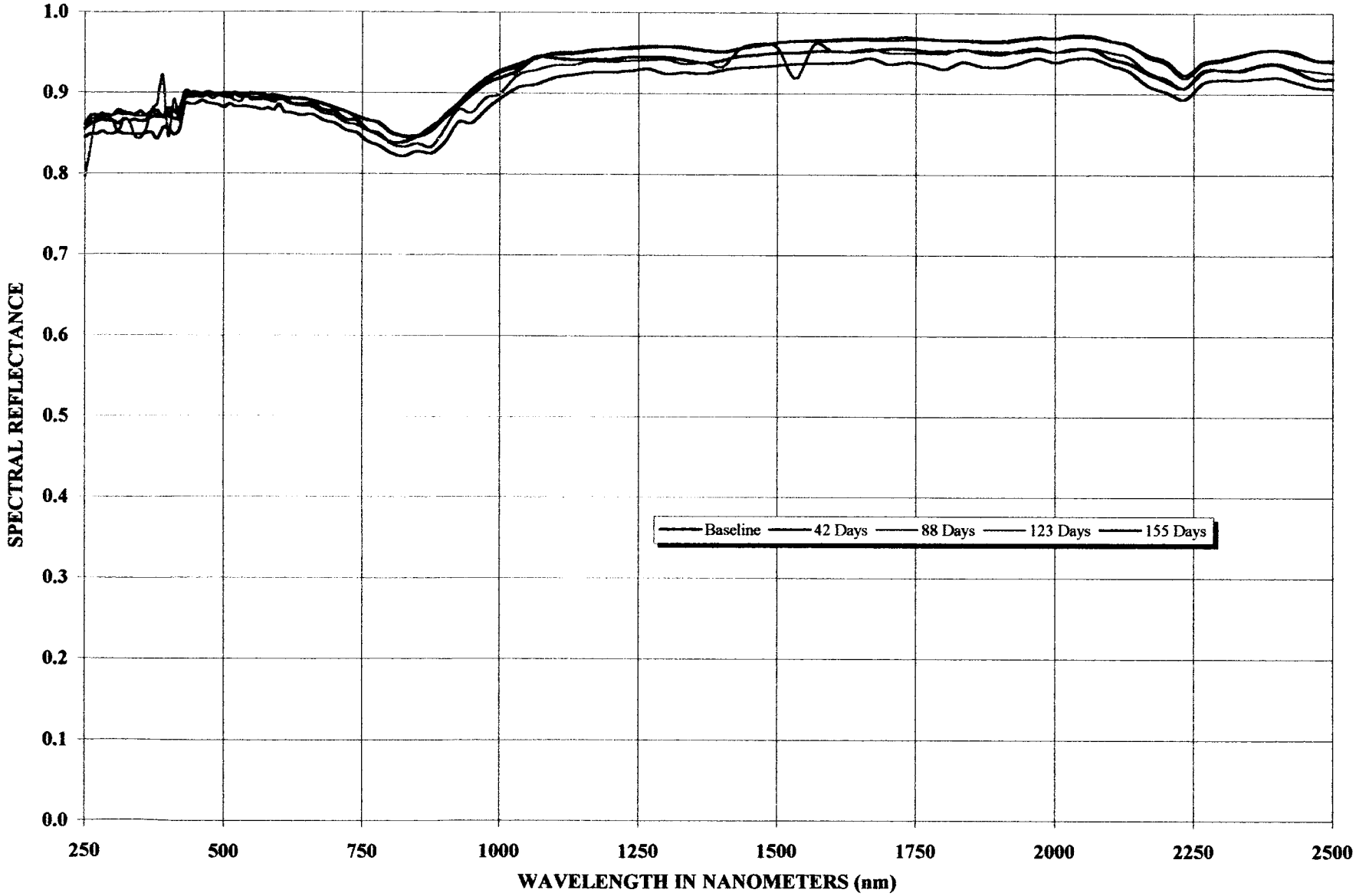
ORIGINAL PAGE
COLOR PHOTOGRAPH



File: CONTROLS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

FUSED SILICA CONTROL WINDOW #3 UV EXPOSURE STUDY - LPSR DATA

155 DAYS SINCE INITIAL SCAN

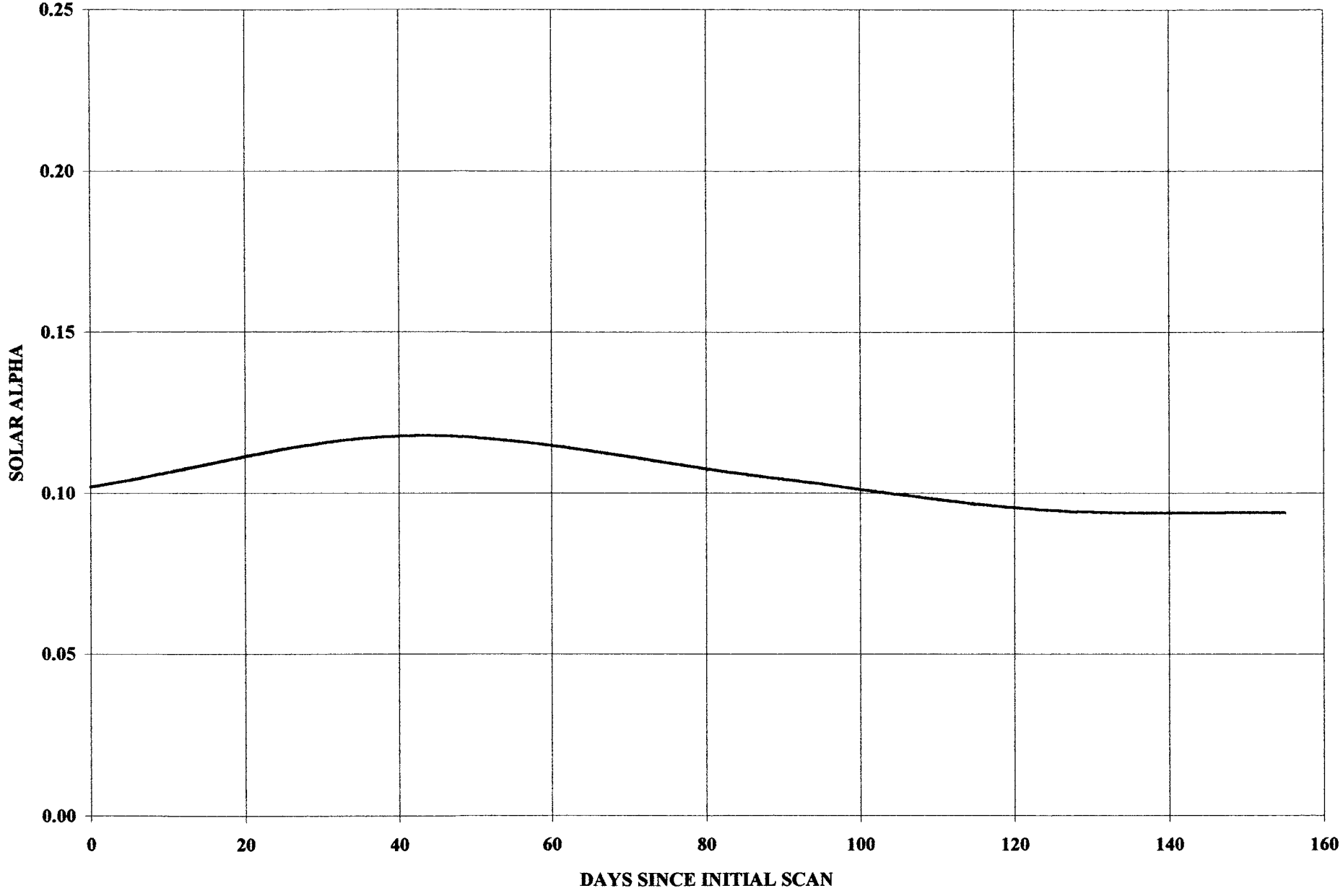


Fused Silica Control Window #3

File: CONTROLS.XLS
Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR CONTROL QUARTZ WINDOW #3

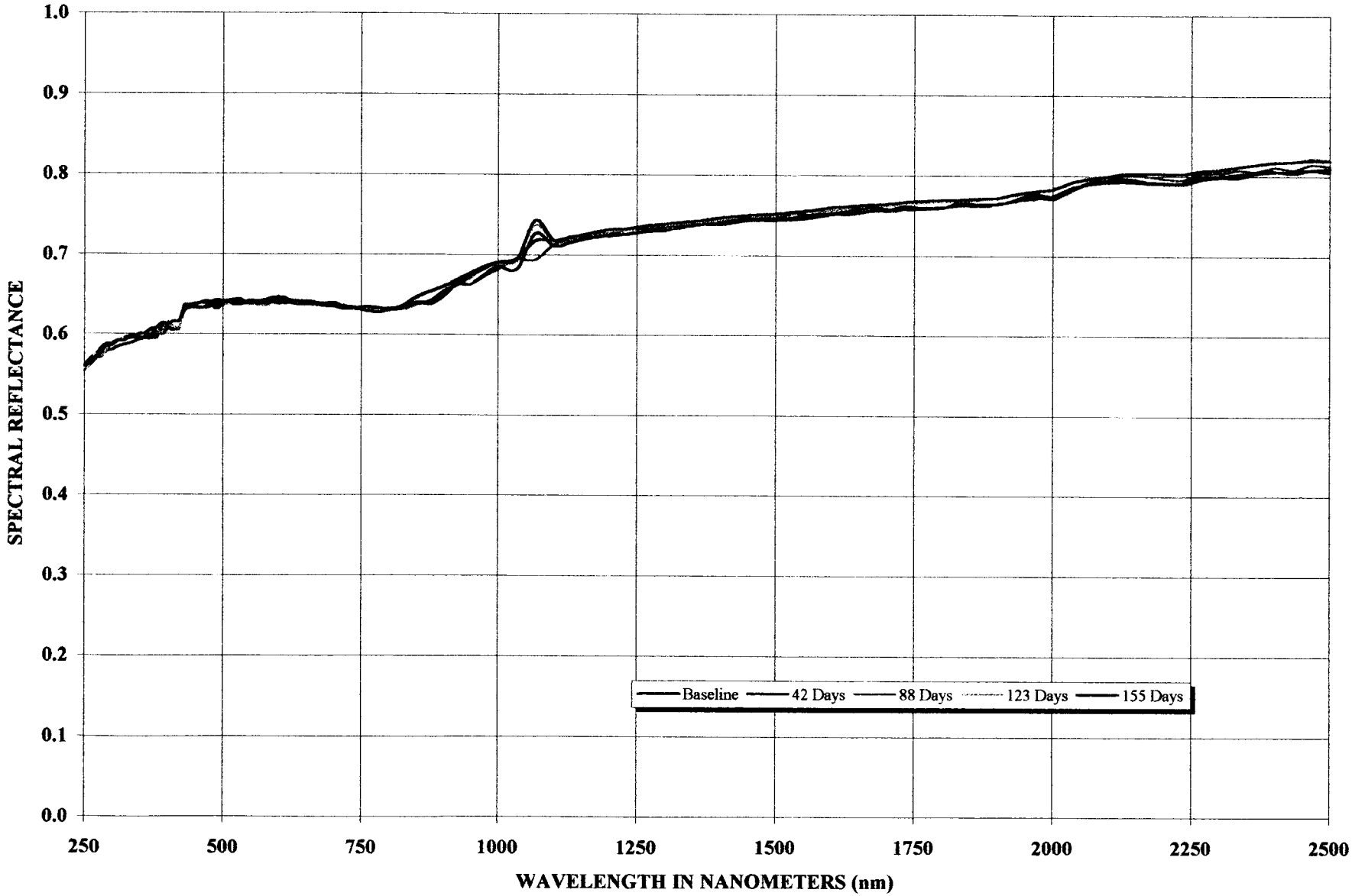
155 DAYS SINCE INITIAL SCAN



File: CONTROLS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

2219 ALUMINUM CONTROL SAMPLE #5 UV EXPOSURE STUDY - LPSR DATA

155 DAYS SINCE INITIAL SCAN

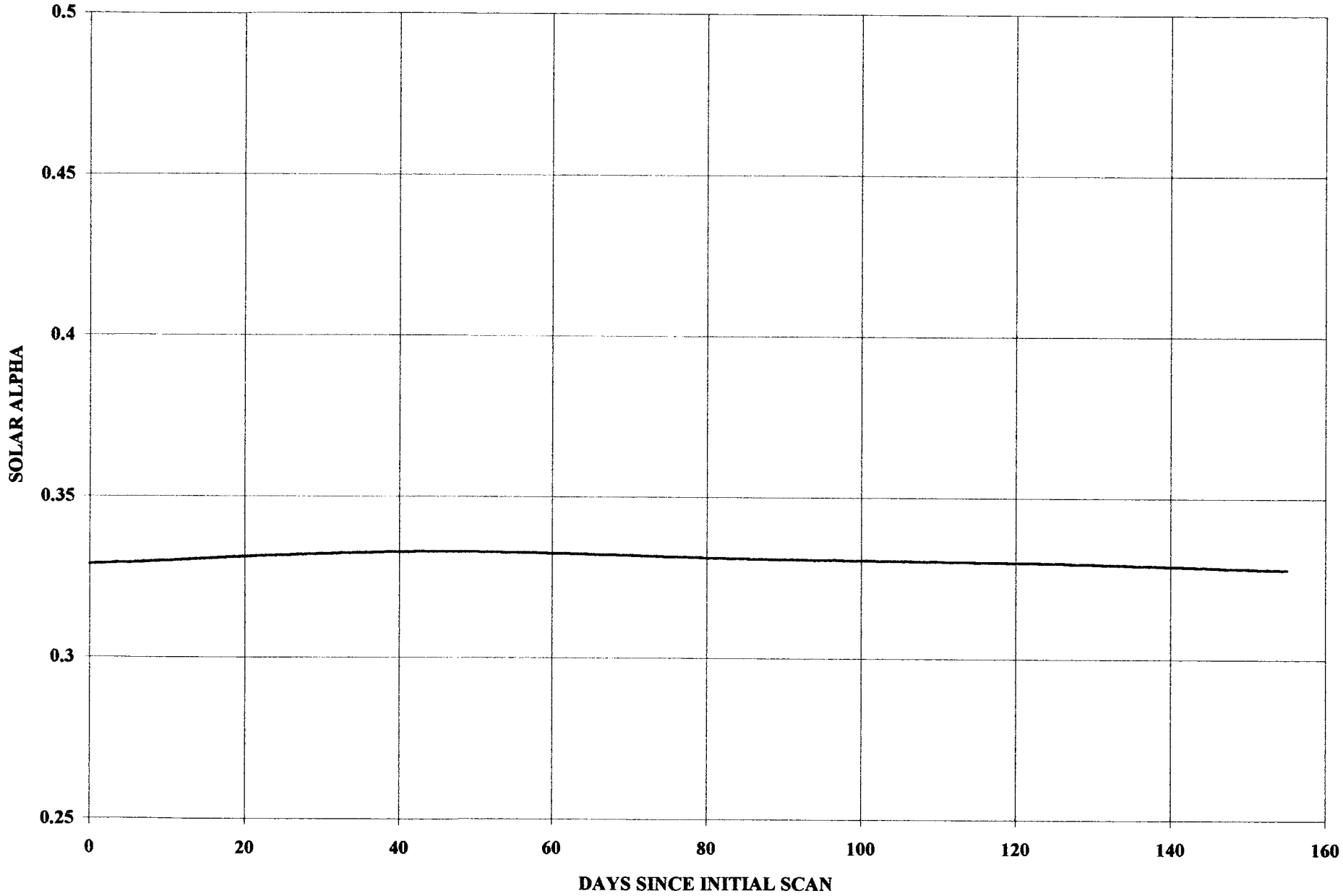


2219 Aluminum Control Sample #5

File: CONTROLS.XLS
Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR 2219 ALUMINUM CONTROL SAMPLE #5

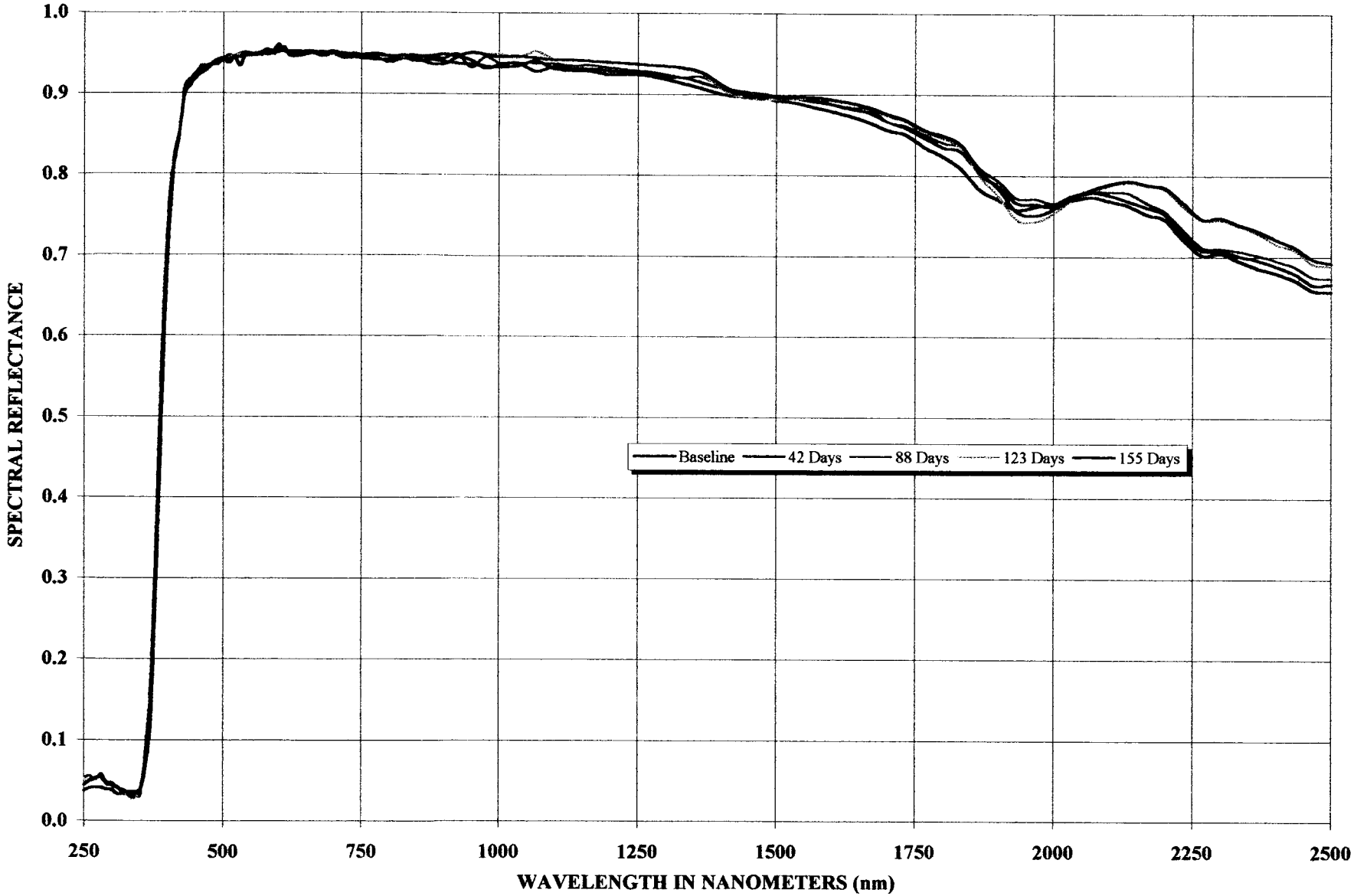
155 DAYS SINCE INITIAL SCAN



File: CONTROLS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

Z-93 WHITE DIFFUSE PAINT #B169-1 CONTROL UV EXPOSURE STUDY - LPSR DATA

155 DAYS SINCE INTIAL LPSR SCAN



Z-93 White Diffuse Paint Control Sample #B169-1

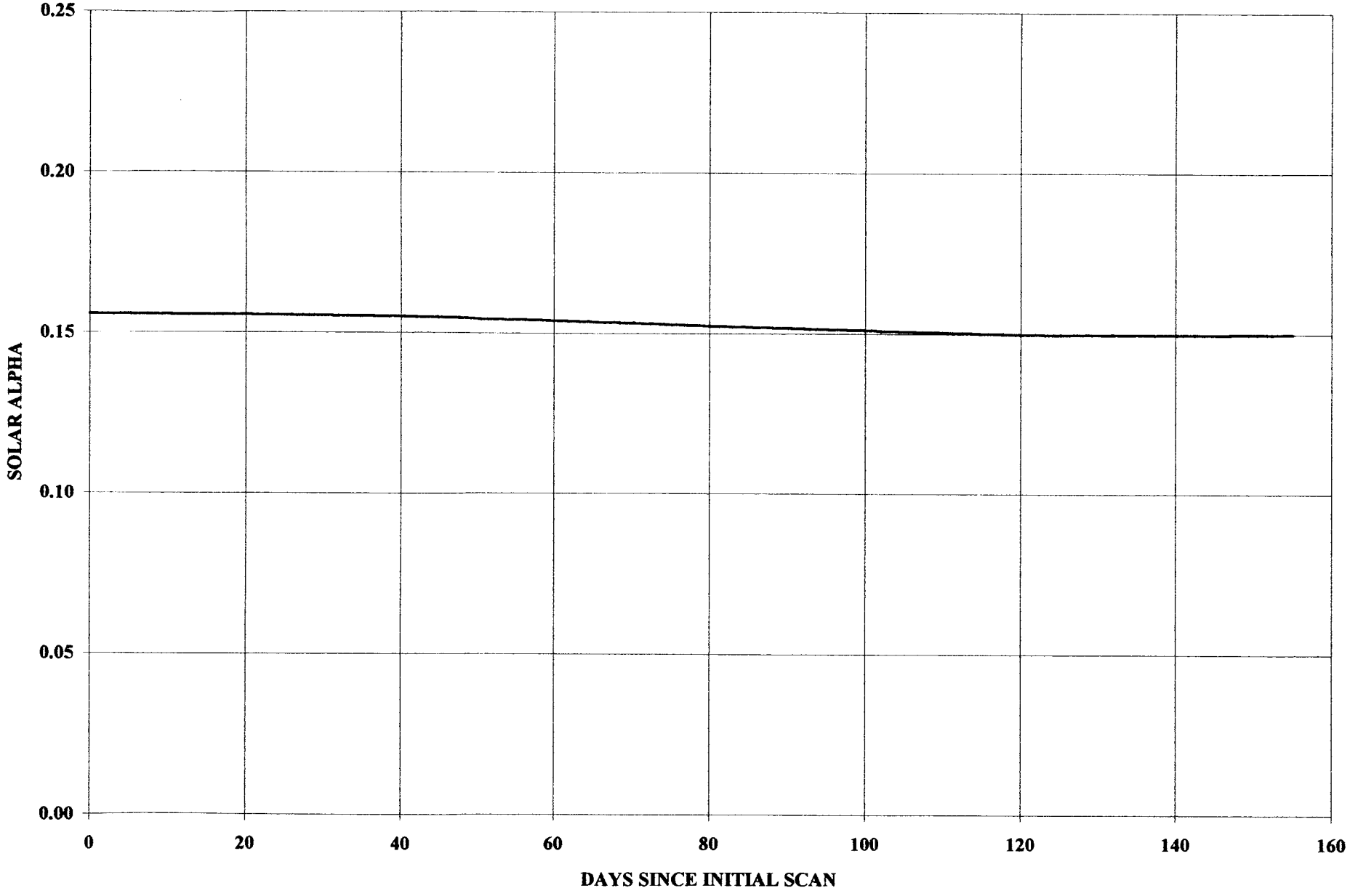
File: CONTROLS.XLS

Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR Z-93 B169-1 CONTROL

155 DAYS FROM INITIAL SCAN

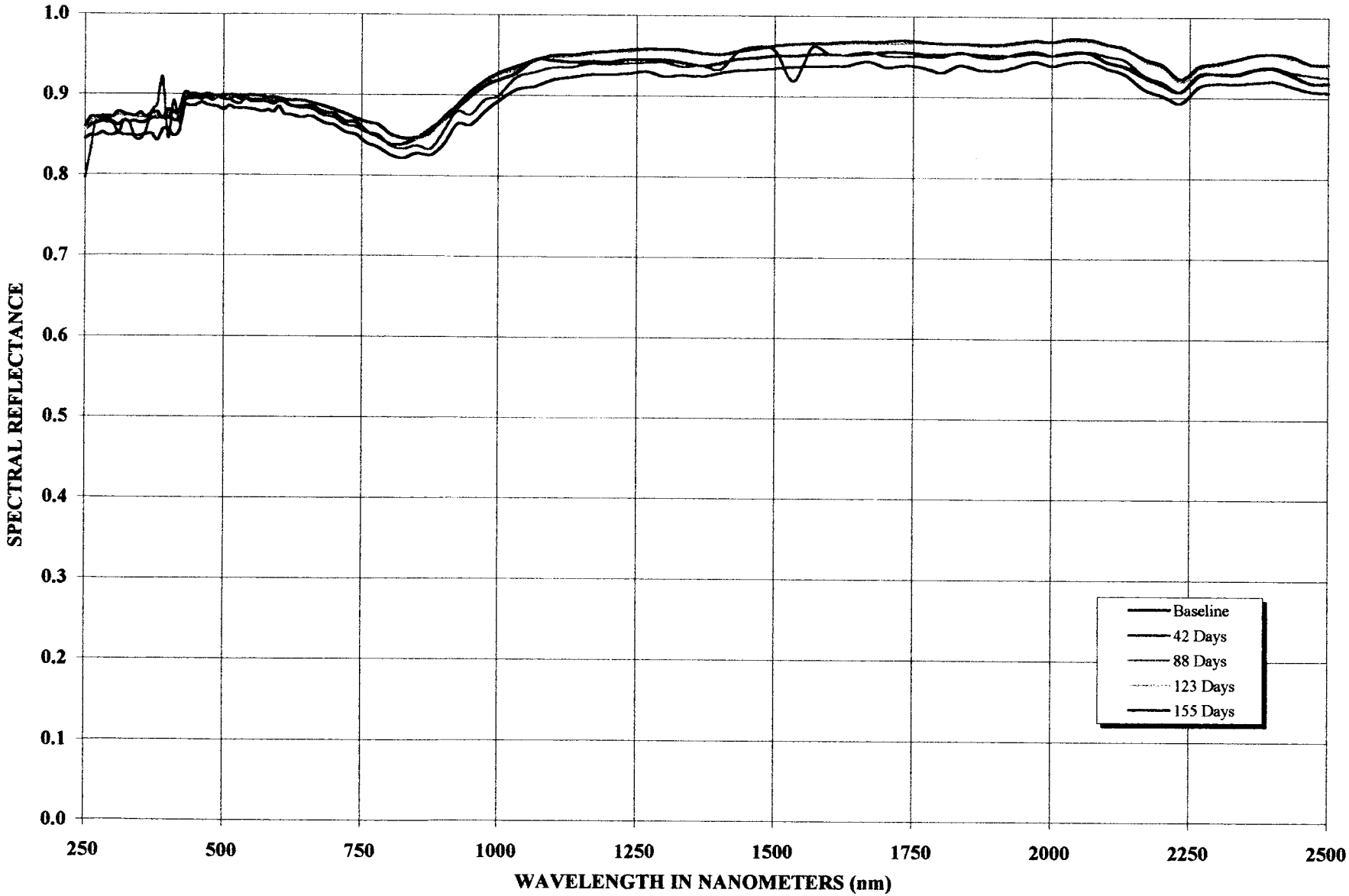
ORIGINAL PAGE
COLOR PHOTOGRAPH



File: CONTROLS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

FUSED SILICA CONTROL WINDOW #3 UV EXPOSURE STUDY - LPSR DATA

155 DAYS FROM INITIAL RUN

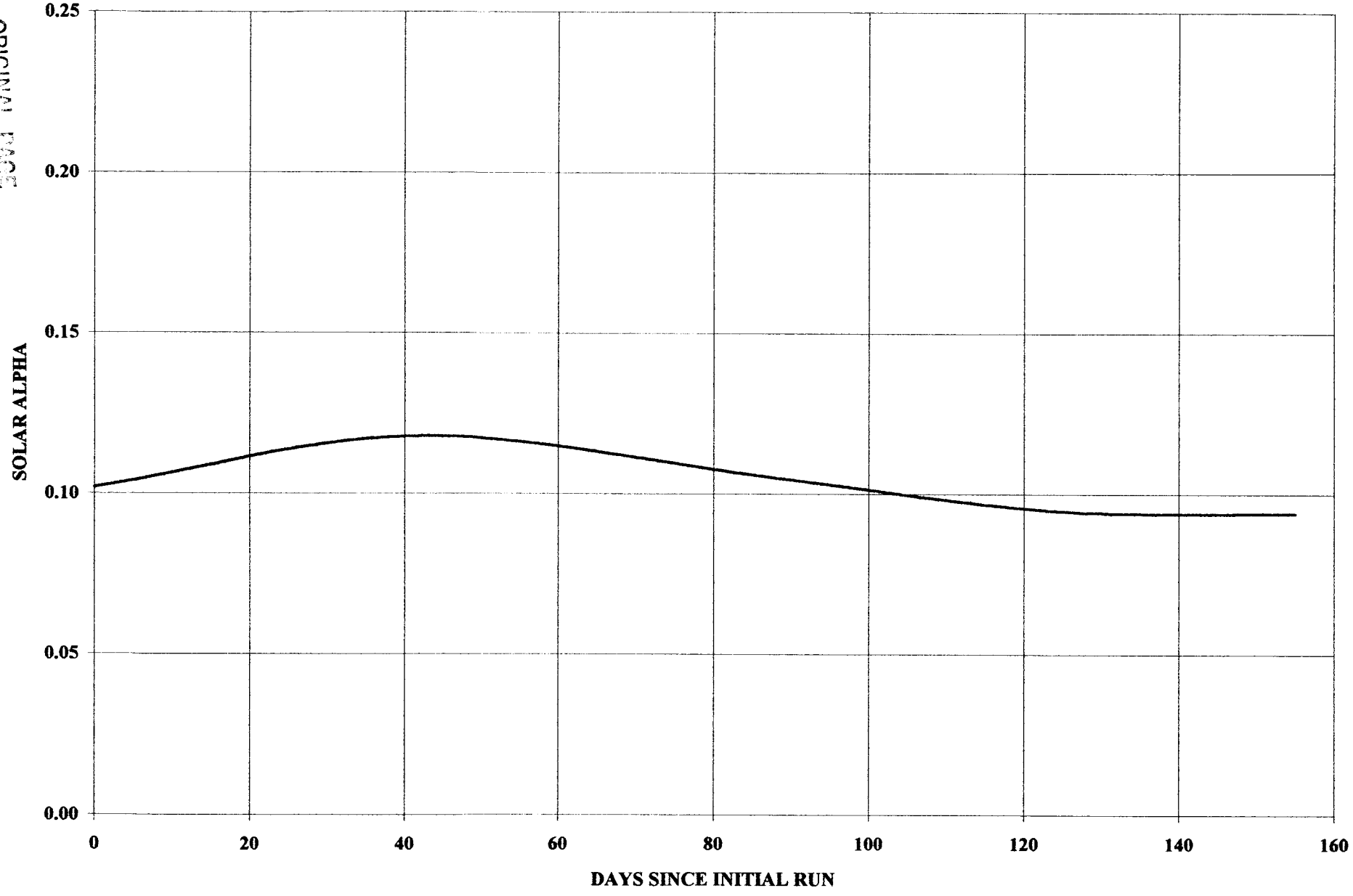


Fused Silica Control Window #3

File: CONTROLS.XLS
Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR FUSED SILICA #3 CONTROL SPECIMAN

ORIGINAL PAGE
OF POOR QUALITY

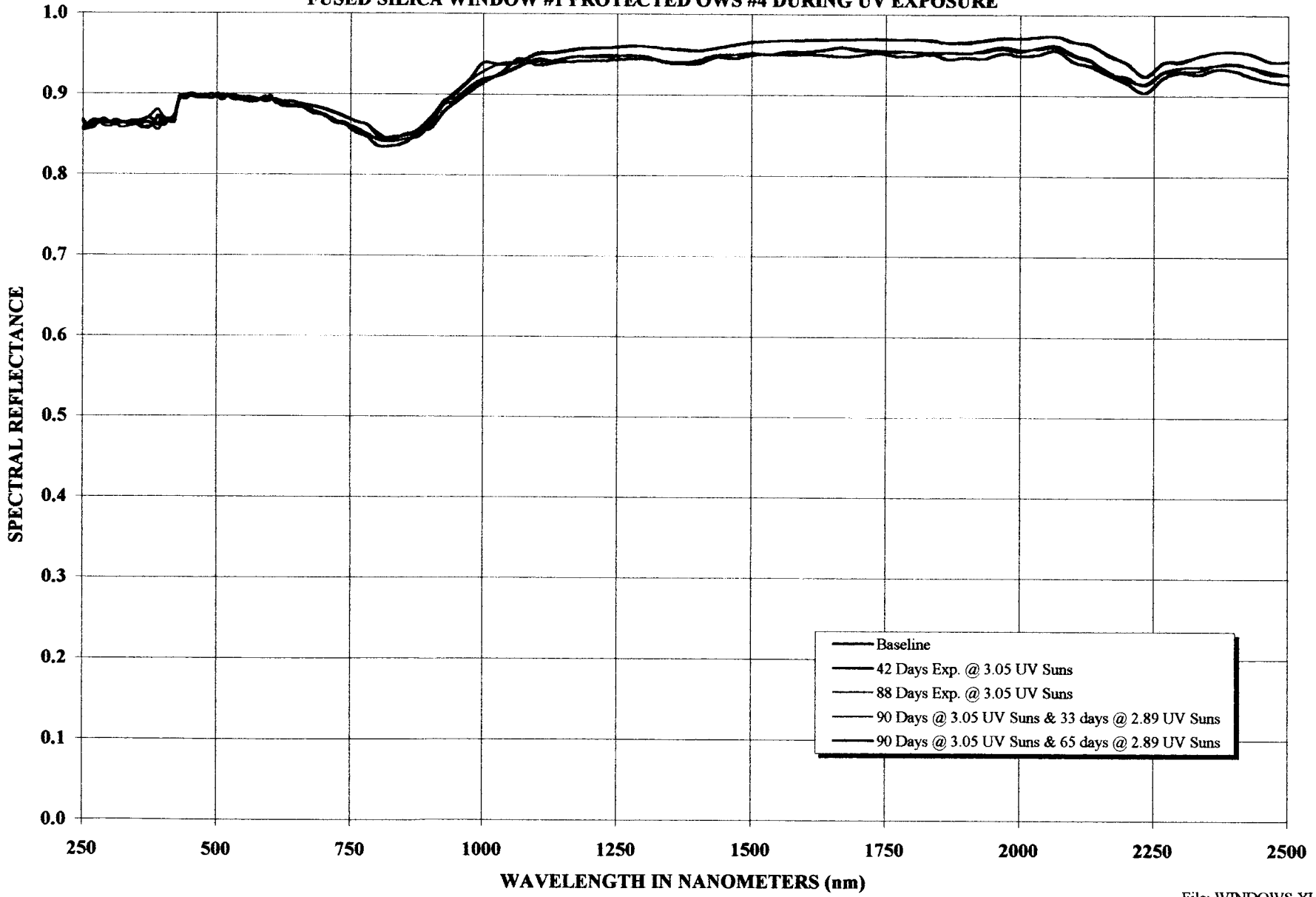


File: CONTROLS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

FUSED SILICA WINDOW #1 - LPSR DATA

BASELINE vs 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS , ALPHA=0.104 BEFORE vs 0.095 AFTER EXPOSURE

FUSED SILICA WINDOW #1 PROTECTED OWS #4 DURING UV EXPOSURE



Fused Silica Window #1 Before and After UV Exposure.

File: WINDOWS.XLS

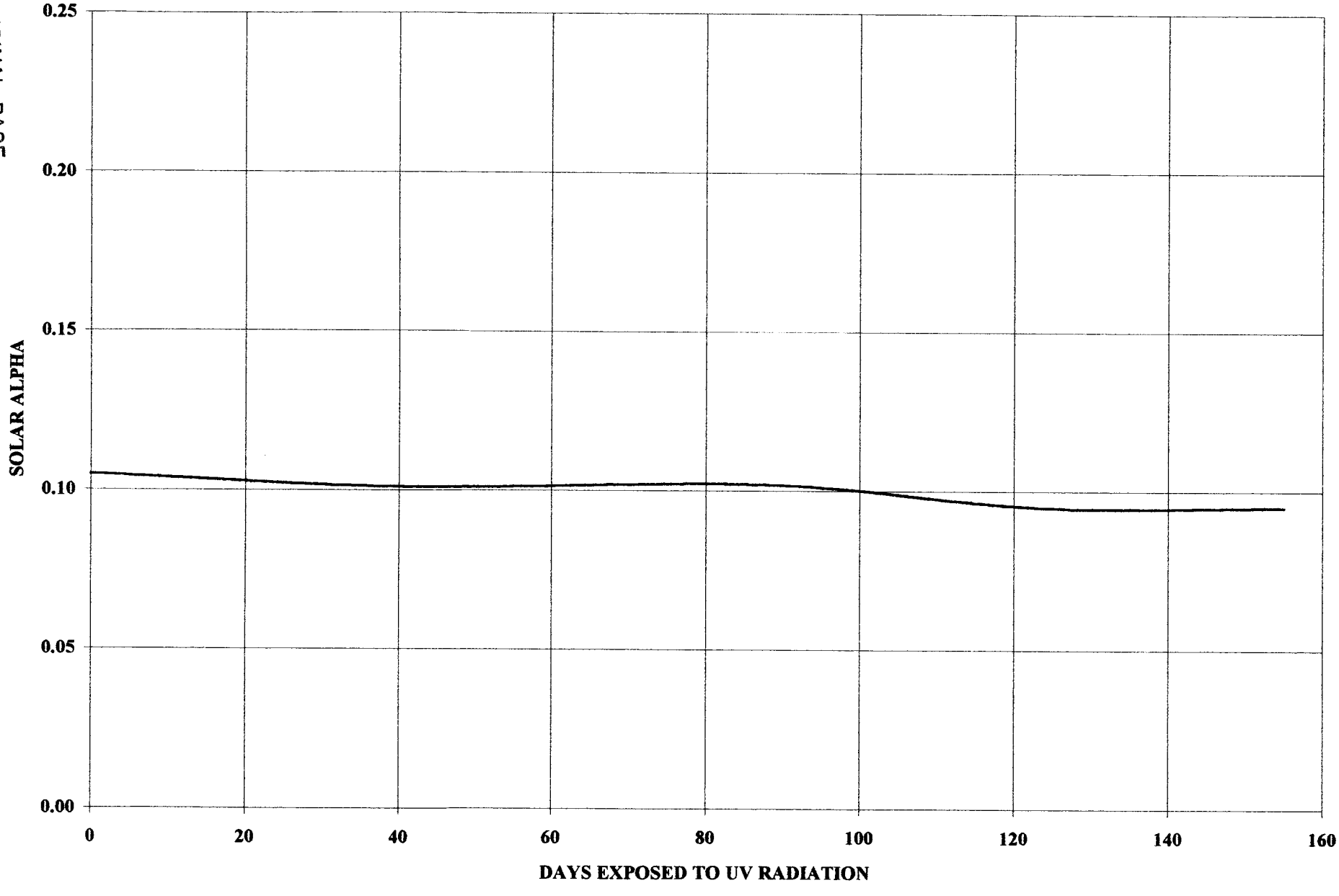
Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR FUSED SILICA WINDOW #1

SAMPLE WAS EXPOSED FOR 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS

FUSED SILICA WINDOW #1 PROTECTED OWS #4 DURING UV EXPOSURE

ORIGINAL PAGE
COLOR PHOTOGRAPH

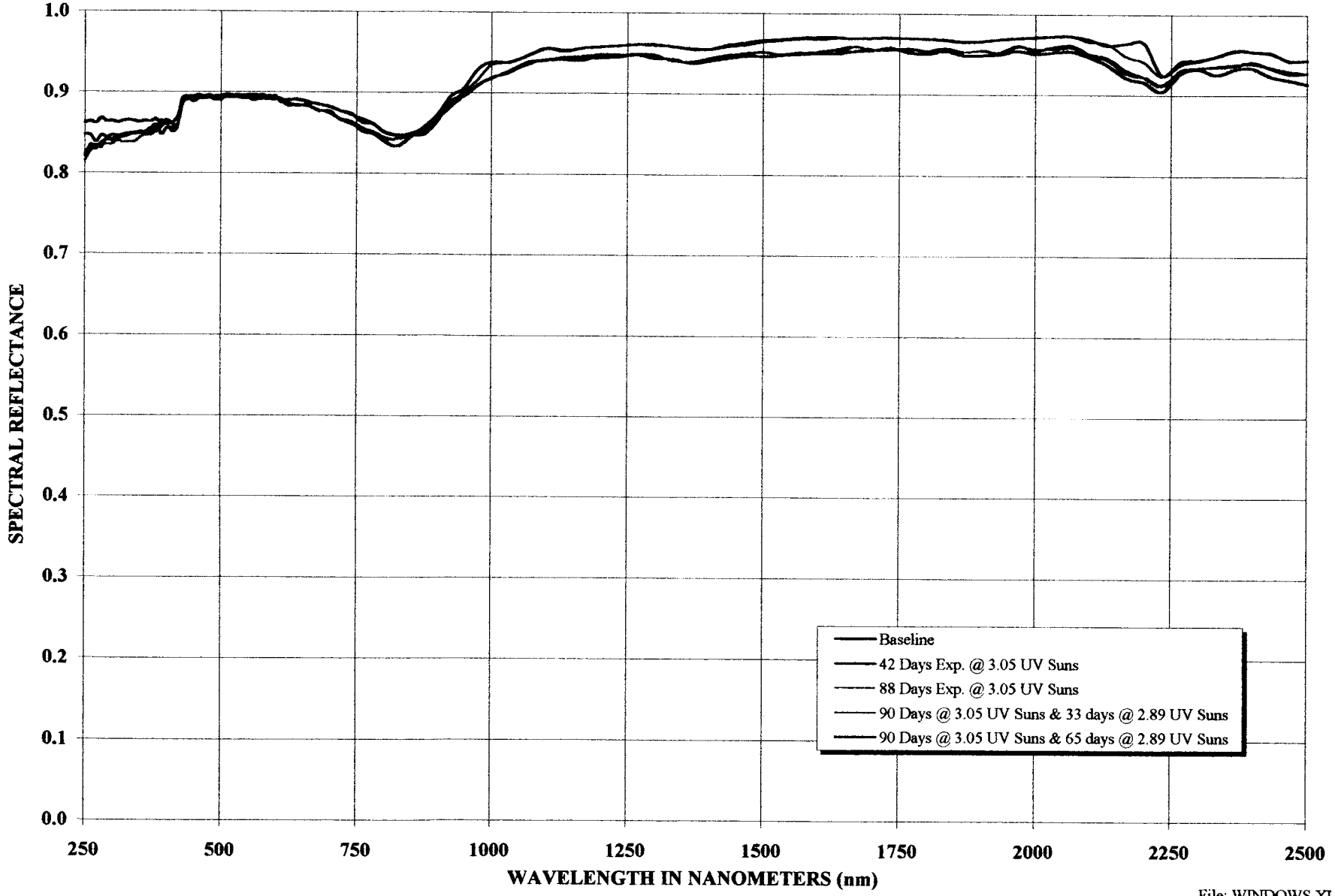


File: WINDOWS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

FUSED SILICA WINDOW #2 - LPSR DATA

BASELINE VS. 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS, ALPHA=0.103 BEFORE AND 0.097 AFTER EXPOSURE

FUSED SILICA WINDOW #2 PROTECTED Z-93 #B169-13 SAMPLE DURING UV EXPOSURE



Fused Silica Window #2 Before and After UV Exposure.

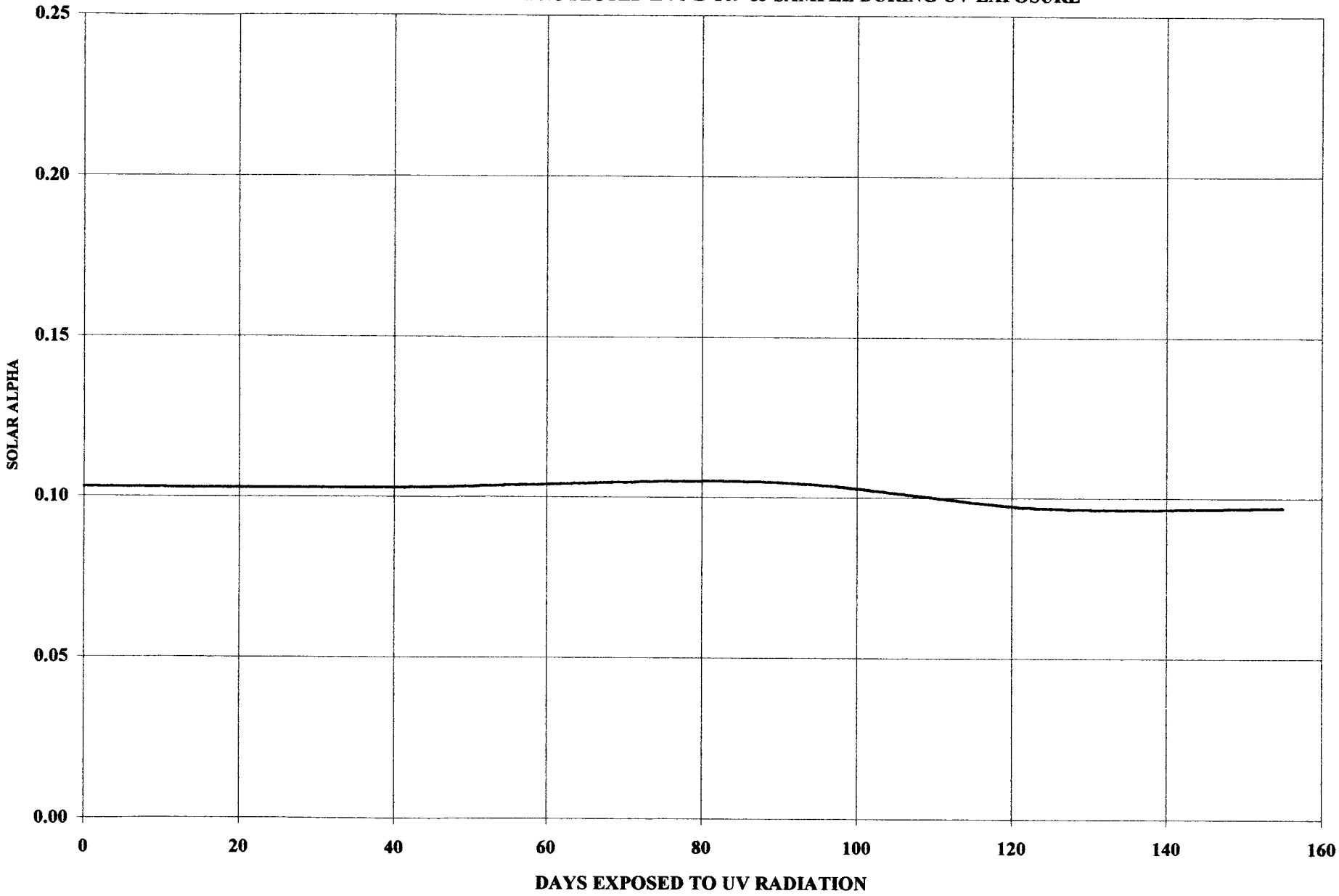
File: WINDOWS.XLS

Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR FUSED SILICA WINDOW #2

SAMPLE WAS EXPOSED FOR 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS

FUSED SILICA WINDOW #2 PROTECTED Z-93 B-169-13 SAMPLE DURING UV EXPOSURE

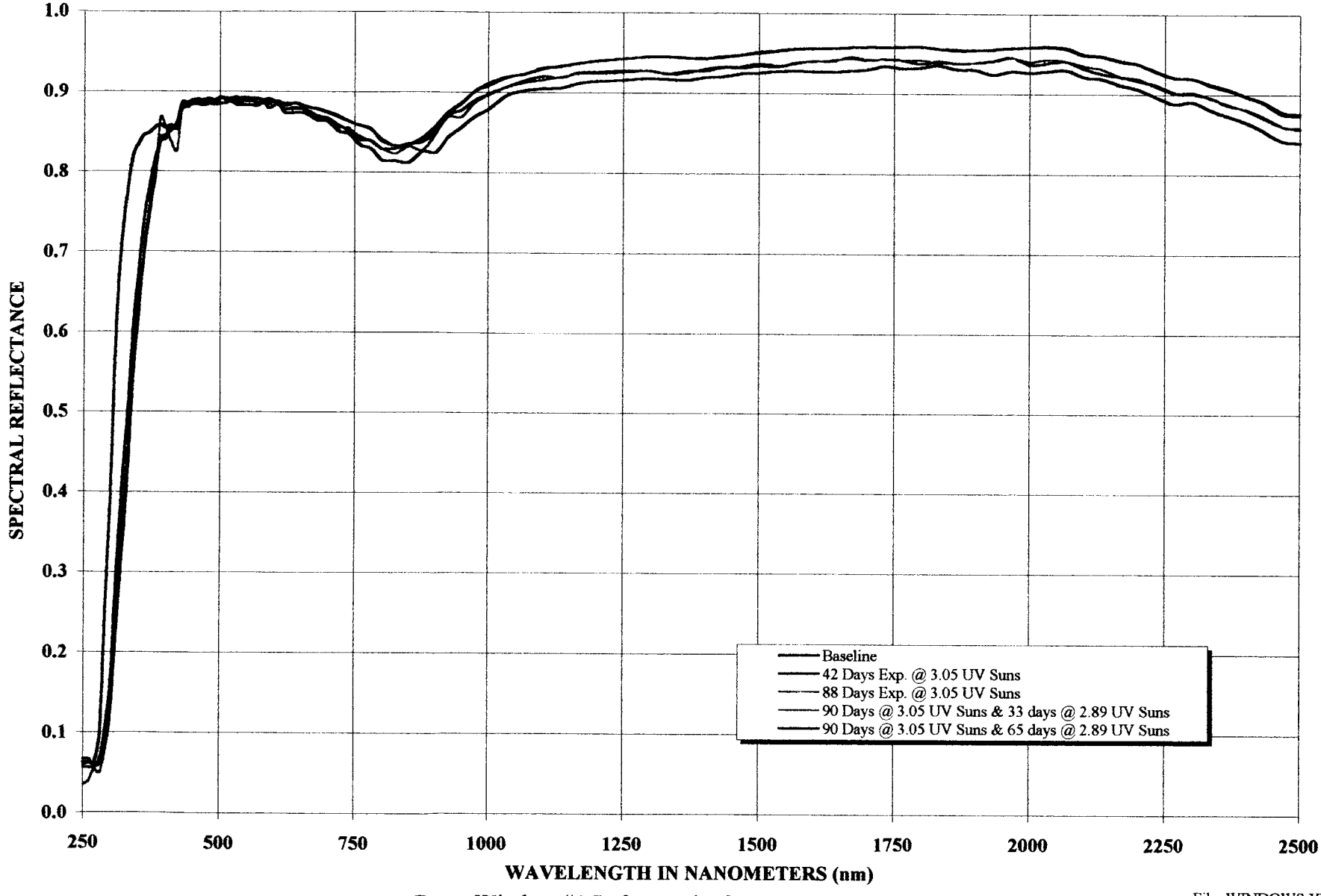


File: WINDOWS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

PYREX WINDOW #1 - LPSR DATA

BASELINE vs 90 DAYS AT 3.05 uv AND 65 DAYS AT 2.89 UV SUNS, ALPHA=0.137 BEFORE vs 0.136 AFTER EXPOSURE

PYREX WINDOW #1 PROTECTED OWS #3 DURING UV EXPOSURE



Pyrex Window #1 Before and After UV Exposure.

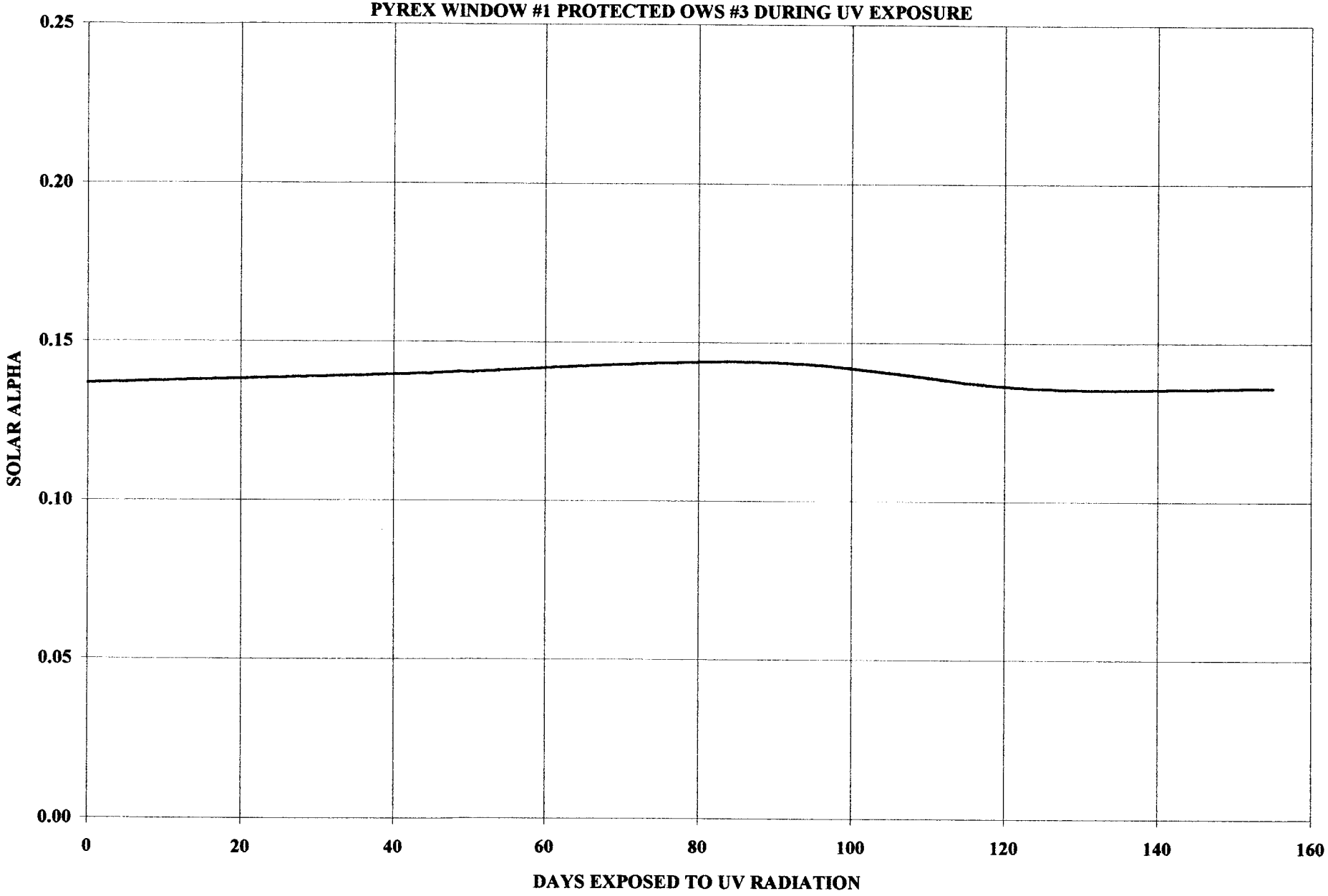
File: WINDOWS.XLS
Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR PYREX WINDOW #1

SAMPLE WAS EXPOSED FOR 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS

PYREX WINDOW #1 PROTECTED OWS #3 DURING UV EXPOSURE

ORIGINAL PAGE
COLOR PHOTOGRAPH

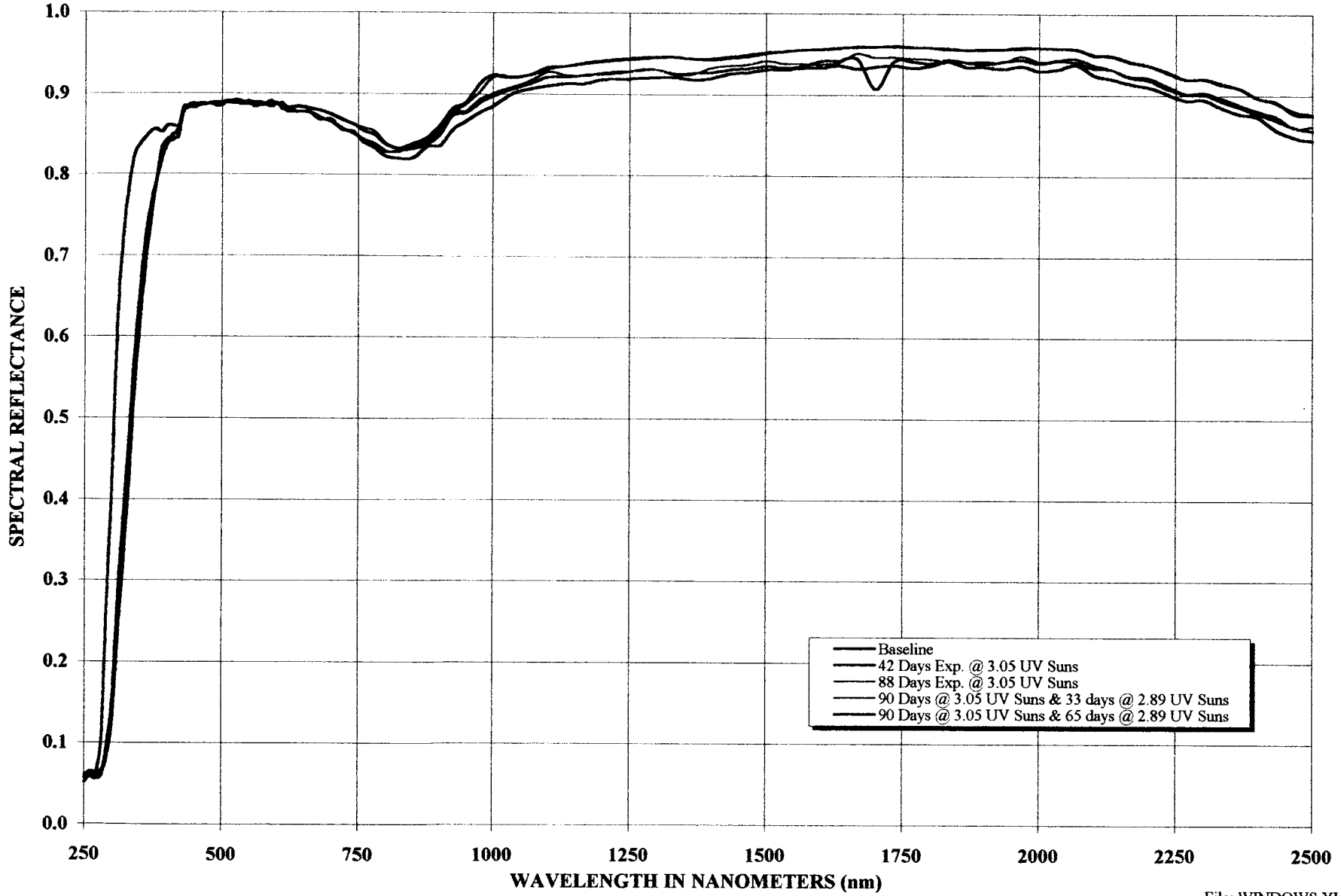


File: WINDOWS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

PYREX WINDOW #2 - LPSR DATA

BASELINE vs 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS, ALPHA=0.133 vs 0.137 AFTER EXPOSURE

PYREX WINDOW #2 PROTECTED Z-93 #B169-7 SAMPLE DURING UV EXPOSURE



Pyrex Window #2 Before and After UV Exposure.

File: WINDOWS.XLS

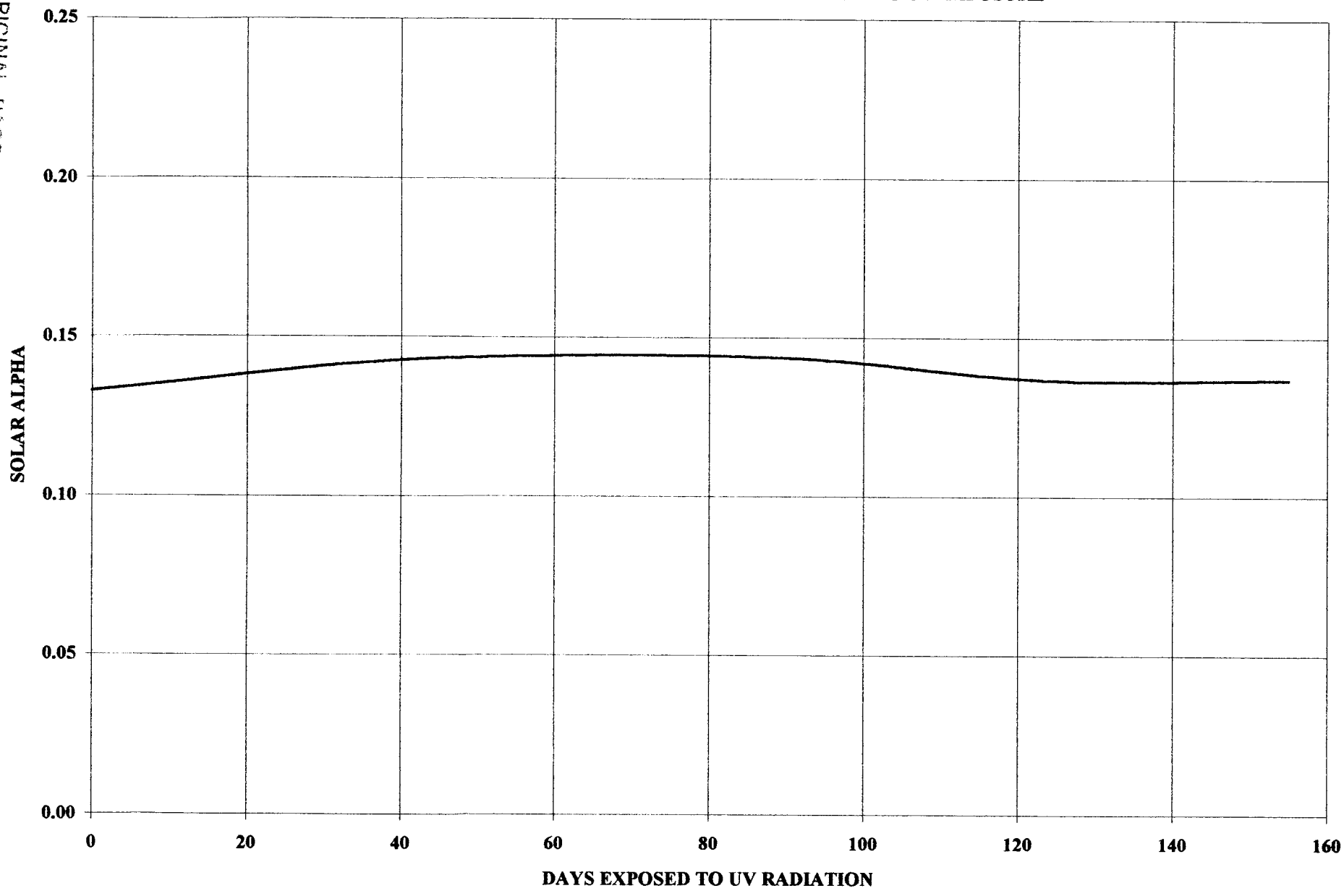
Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR PYREX WINDOW #2

SAMPLE WAS EXPOSED FOR 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS

PYREX WINDOW #2 PROTECTED Z-93 B169-7 SAMPLE DURING UV EXPOSURE

ORIGINAL PAGE
COLOR PHOTOGRAPH

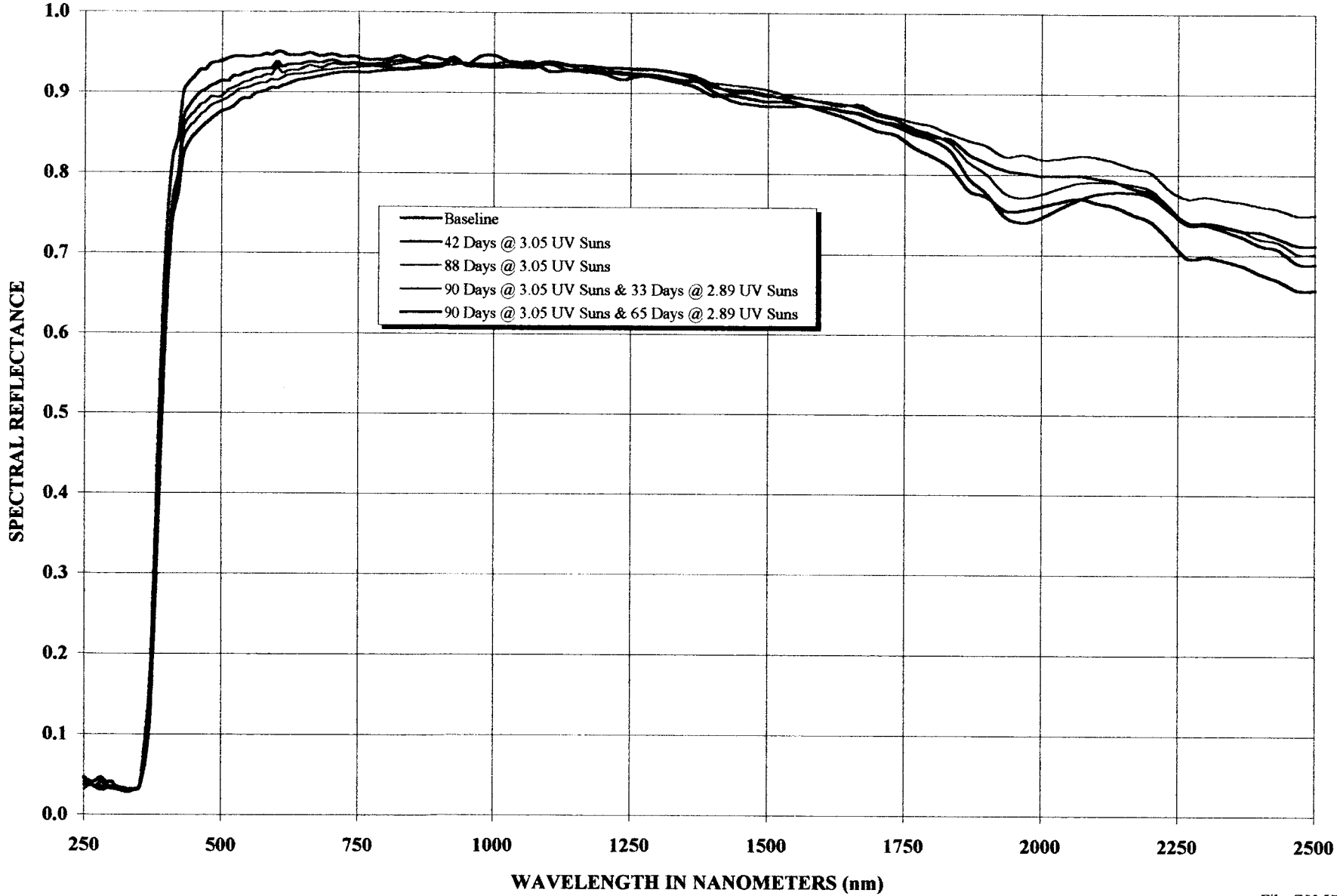


File: WINDOWS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

Z-93 WHITE DIFFUSE PAINT SAMPLE #B169-3 - LPSR DATA

BASELINE VS 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS, ALPHA=0.157 BEFORE VS 0.179 AFTER EXPOSURE

Z-93 #B169-3 WAS NOT PROTECTED WITH A WINDOW DURING UV EXPOSURE



Z-93 White Diffuse Paint Sample #B169-3 Before and After Exposure.

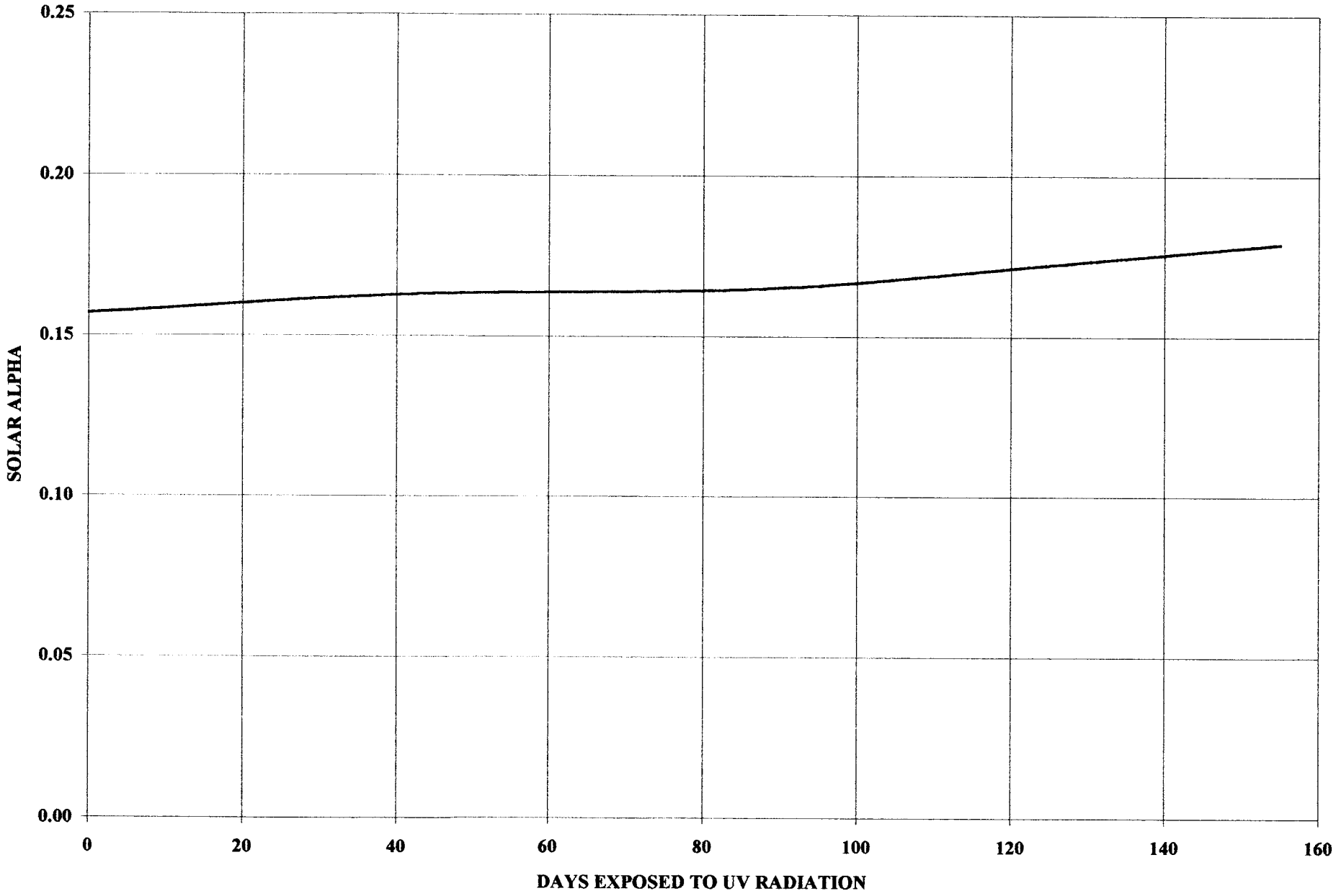
File: Z93.XLS

Data Taken: 1/05/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR Z-93 WHITE DIFFUSE PAINT SAMPLE #B169-3

Z-93 #B169-3 WAS NOT PROTECTED WITH A WINDOW DURING EXPOSURE

ORIGINAL PAGE
COLOR PHOTOGRAPH

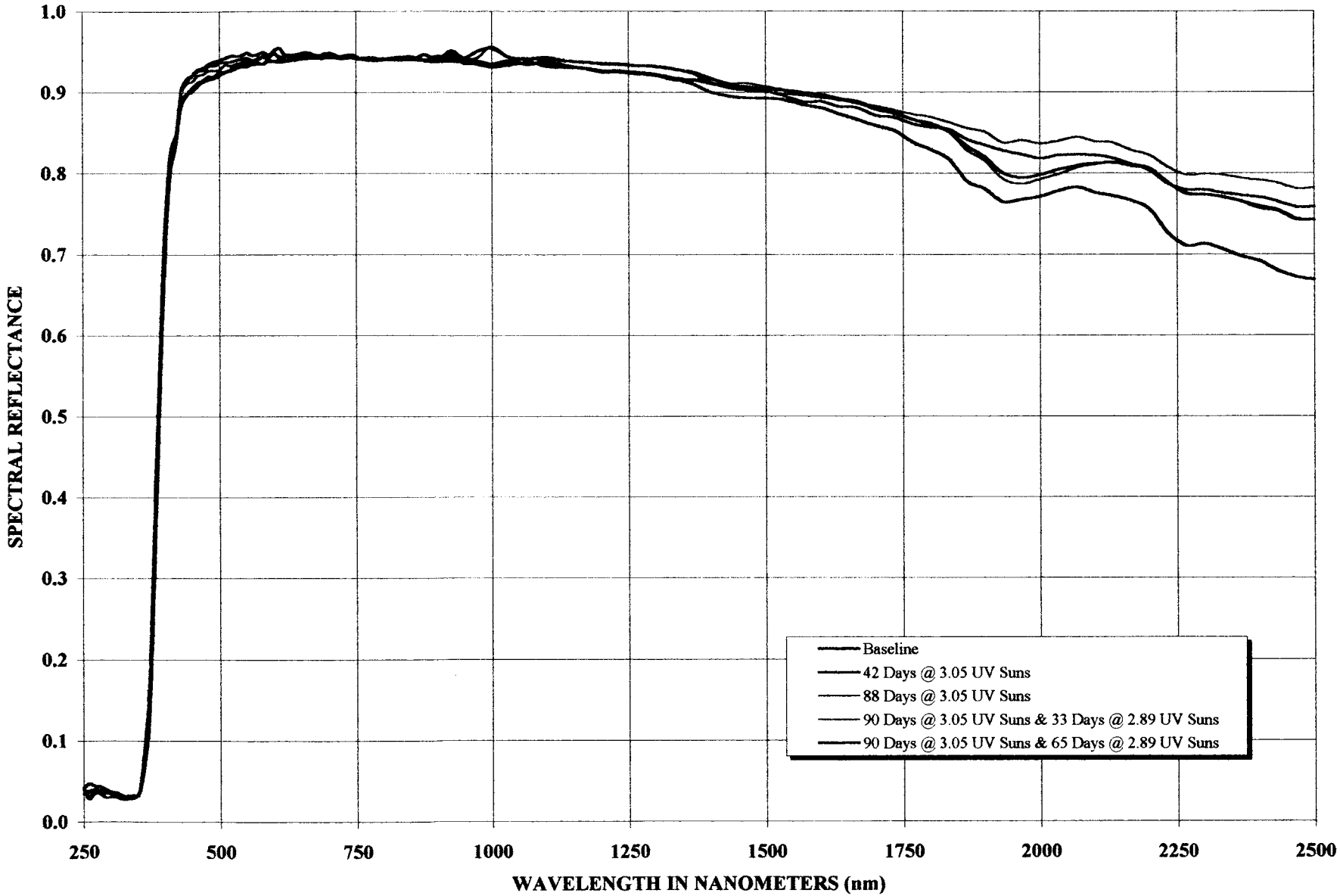


File: Z93.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

Z-93 WHITE DIFFUSE PAINT SAMPLE #B169-7 - LPSR DATA

BASELINE VS 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS, ALPHA=0.155 BEFORE VS 0.154 AFTER EXPOSURE

Z-93 #B169-7 PROTECTED WITH A PYREX WINDOW #2 DURING UV EXPOSURE

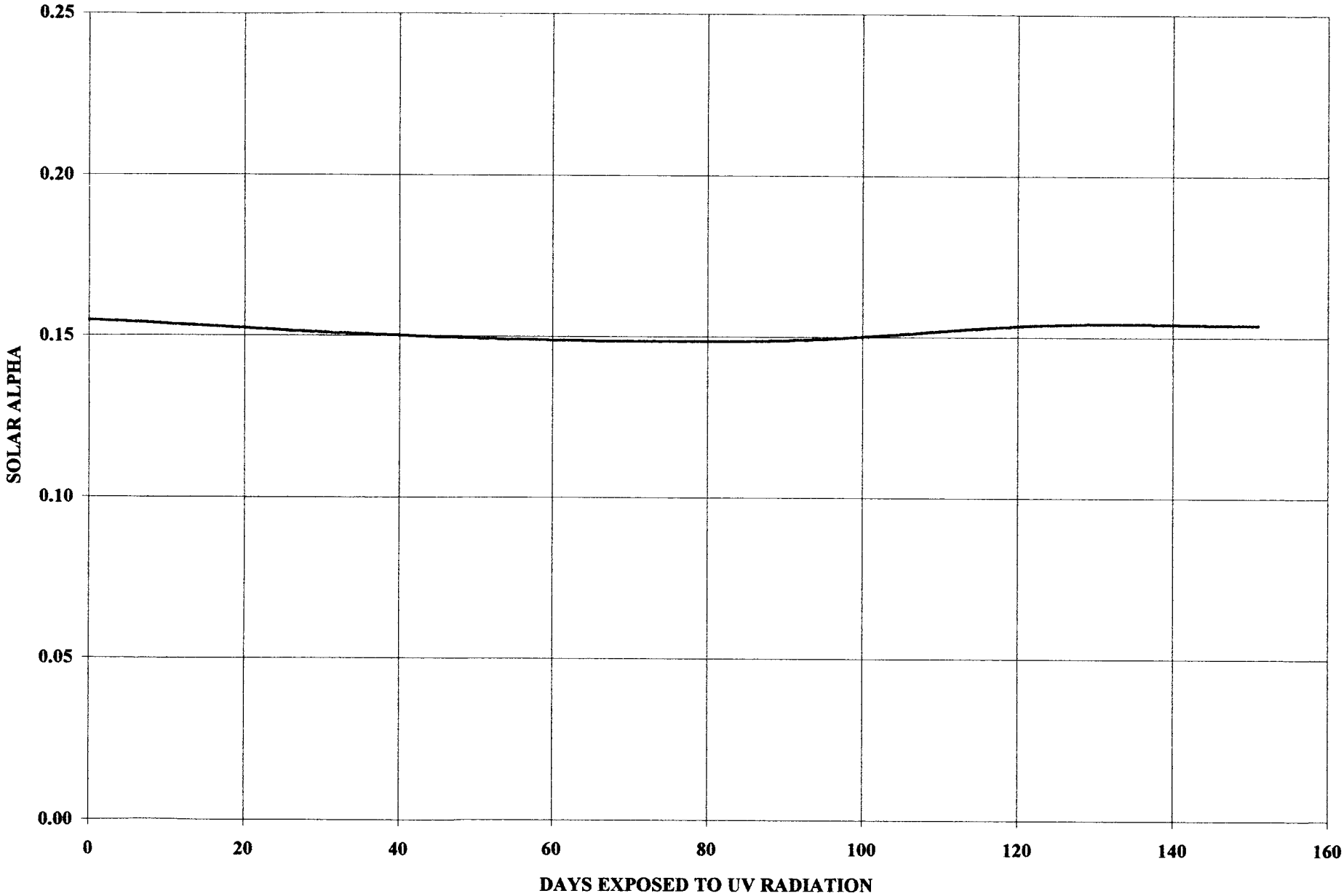


Z-93 White Diffuse Paint Sample #B169-7 Before and After Exposure.

File: Z93.XLS
Data Taken: 1/05/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR Z-93 WHITE DIFFUSE PAINT SAMPLE #B169-7

Z-93 #B169-7 WAS PROTECTED WITH PYREX WINDOW #2 DURING UV EXPOSURE



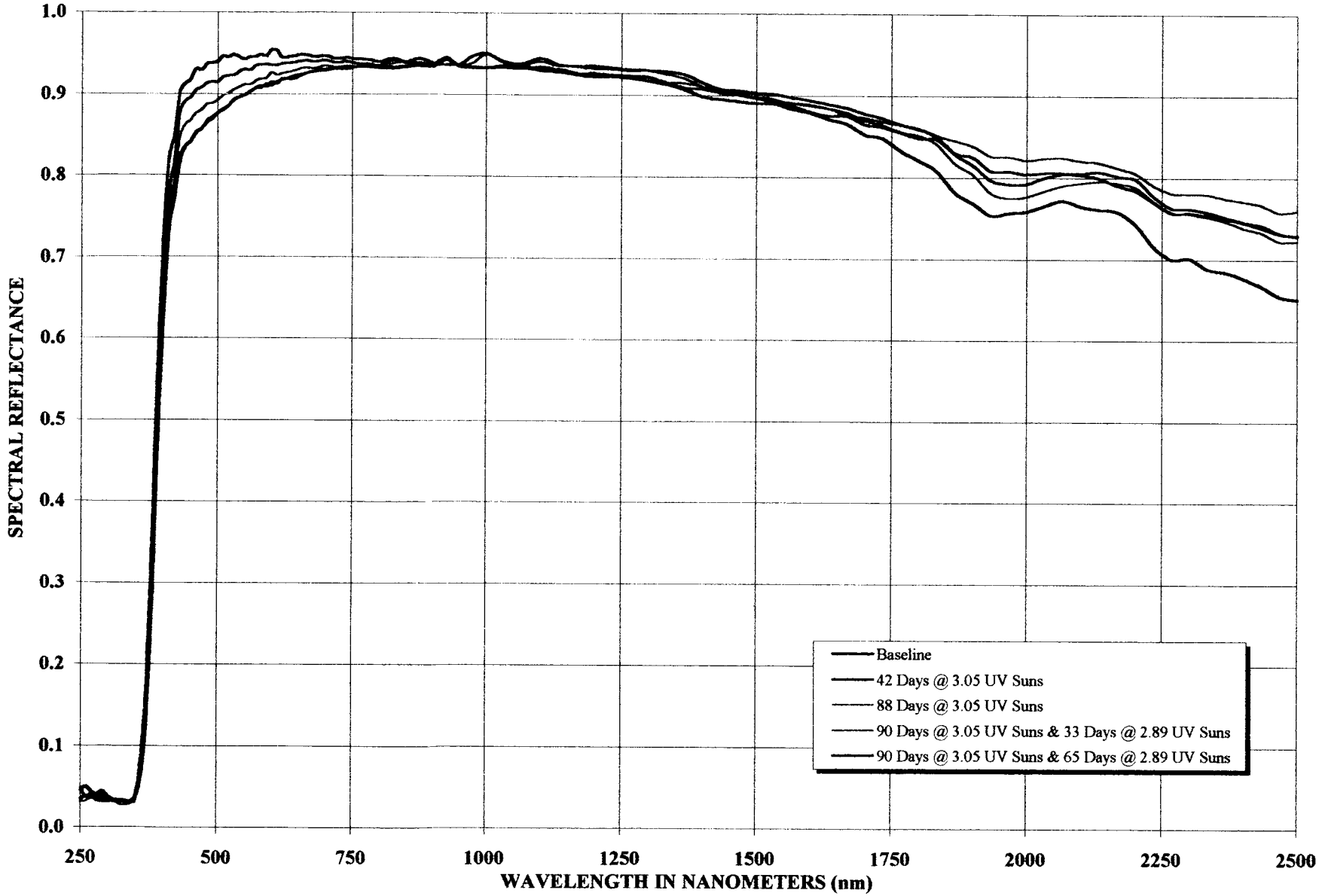
File: Z93.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

ORIGINAL PAGE
COLOR PHOTOGRAPH

Z-93 WHITE DIFFUSE PAINT SAMPLE #B169-13 - LPSR DATA

BASELINE VS 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS, ALPHA=0.157 BEFORE VS 0.173 AFTER EXPOSURE

Z-93 #B169-13 PROTECTED WITH QUARTZ WINDOW #2 DURING UV EXPOSURE

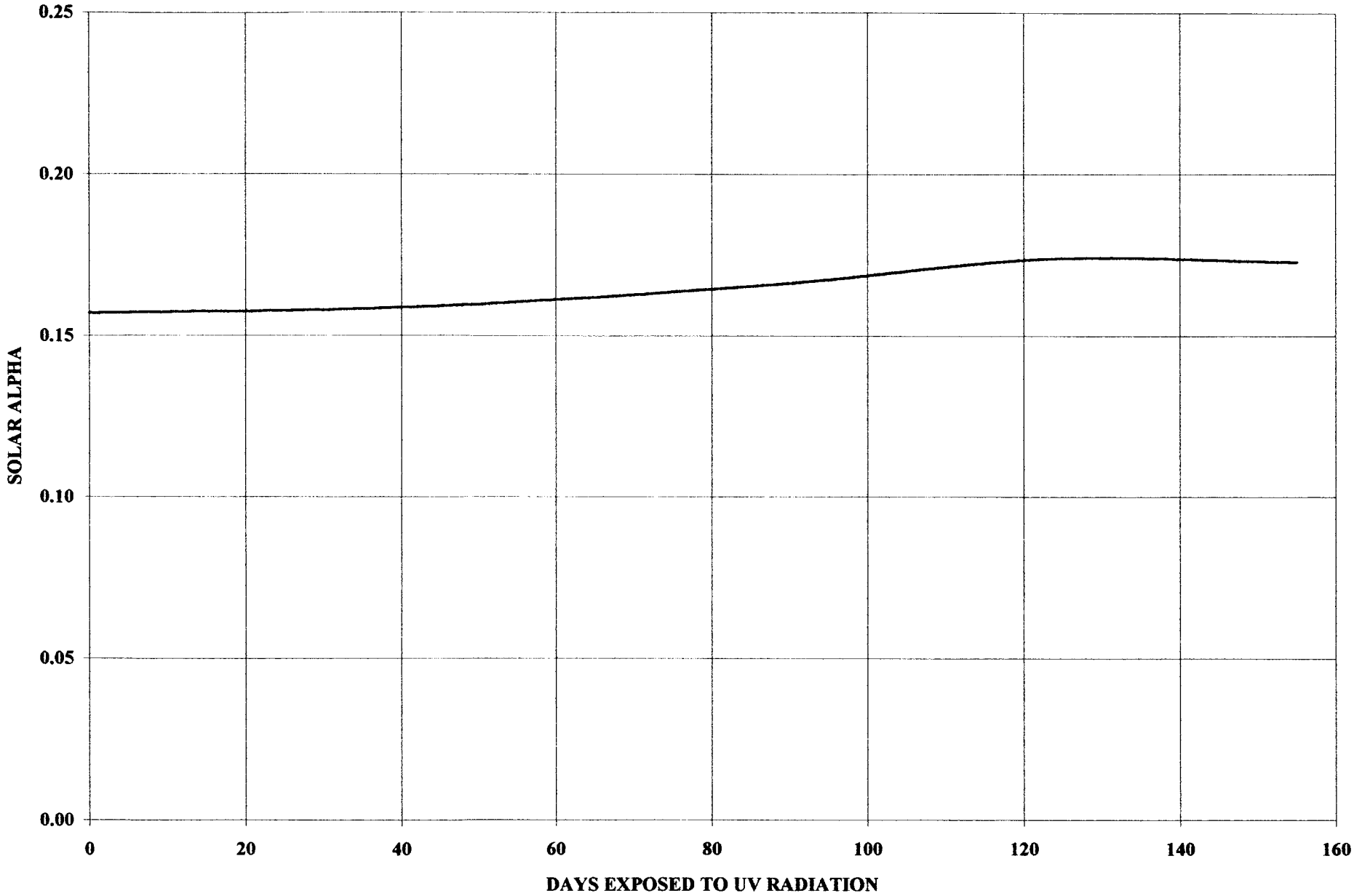


Z-93 White Diffuse Paint Sample #B169-13 Before and After UV Exposure.

File: Z93.XLS
Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR Z-93 WHITE DIFFUSE PAINT SAMPLE #B169-13

Z-93 #B169-13 WAS PROTECTED WITH QUARTZ WINDOW #2 DURING EXPOSURE

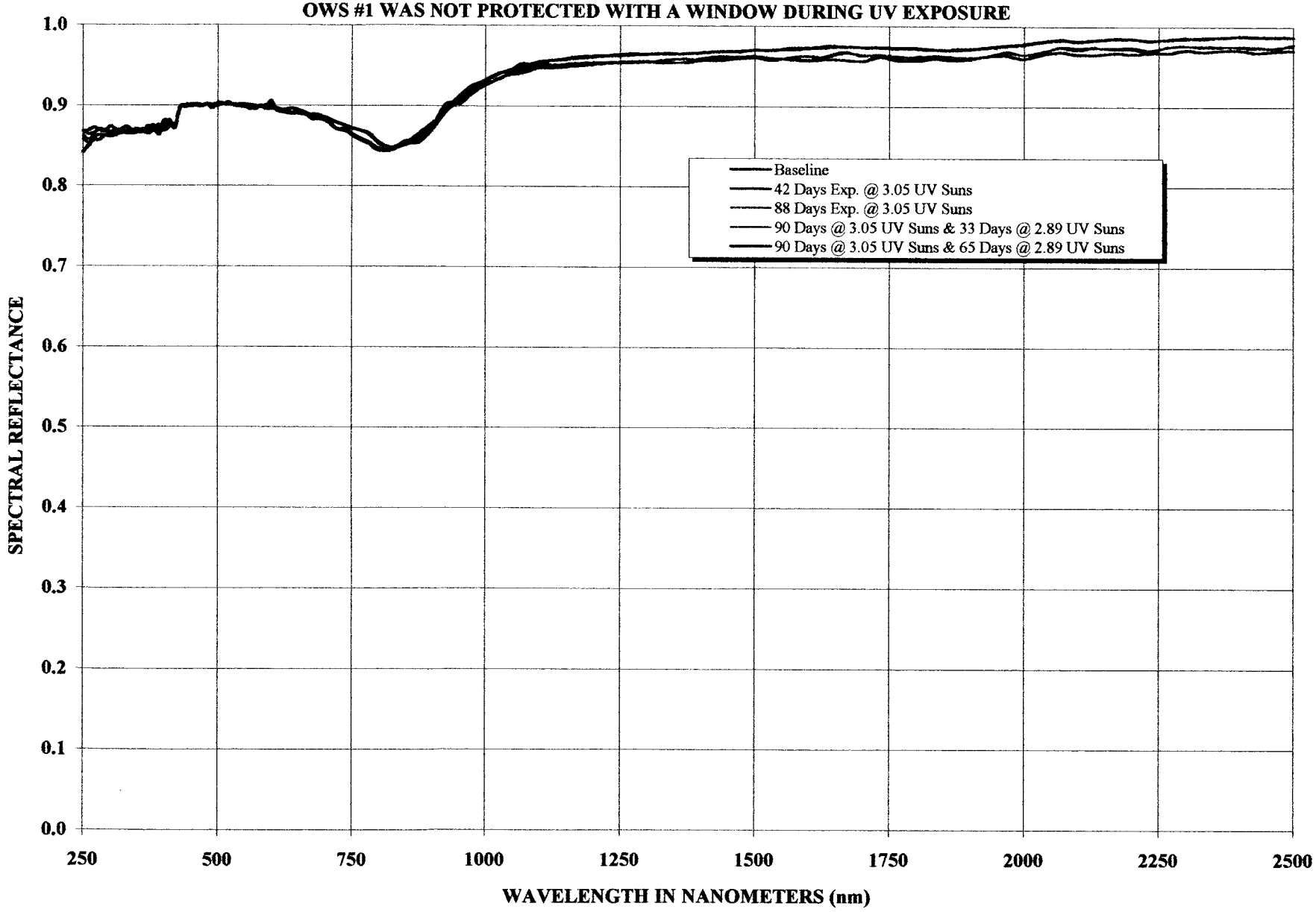


File: Z93.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

OPTICAL WITNESS SAMPLE #1 - LPSR DATA

BASELINE VS. 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS, ALPHA=0.093 BEFORE AND 0.089 AFTER EXPOSURE

OWS #1 WAS NOT PROTECTED WITH A WINDOW DURING UV EXPOSURE



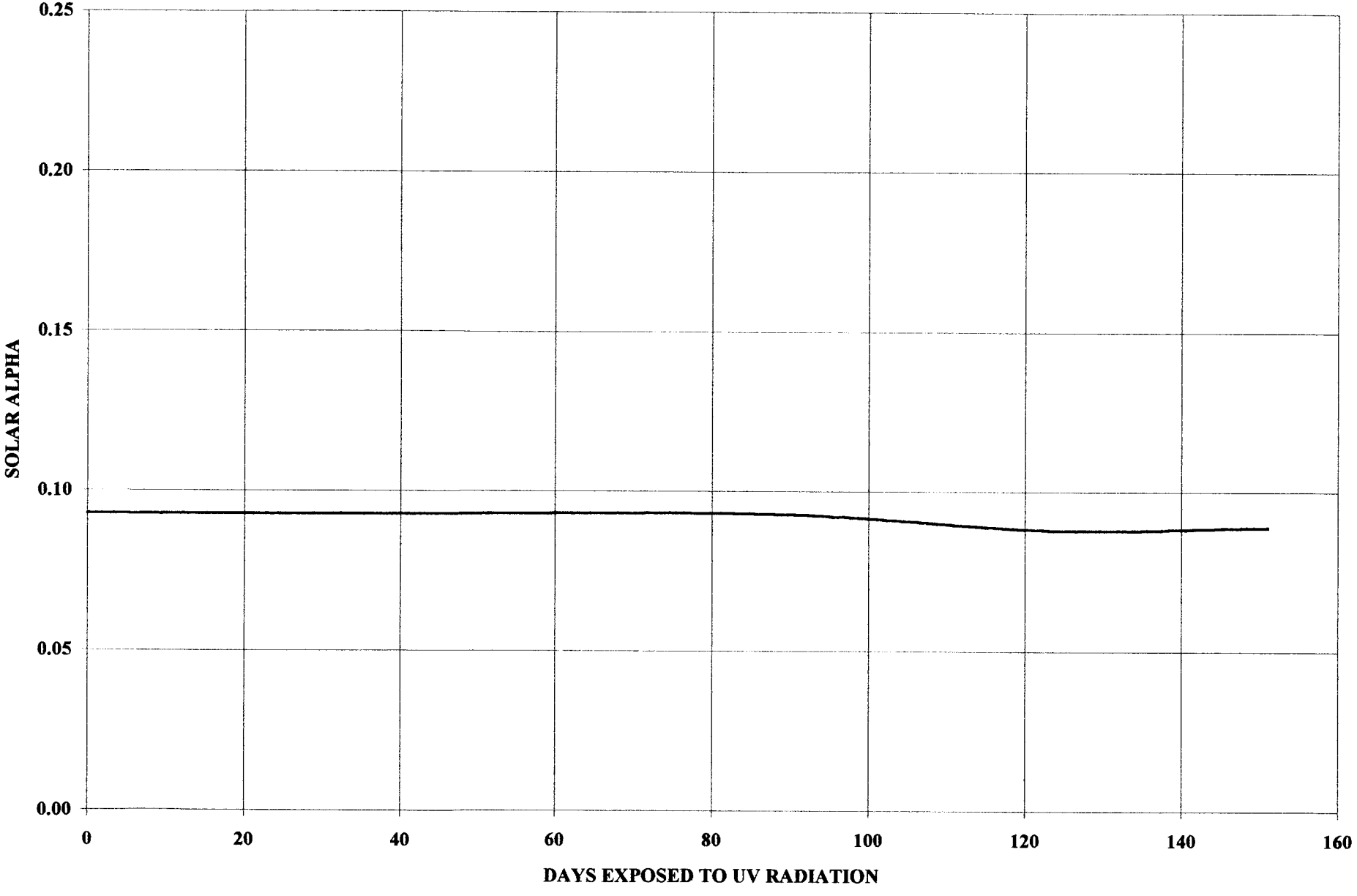
Optical Witness Sample #1 Before and After Exposure.

File: OWS.XLS
Data Taken: 1/5/95, 2/16/95, 4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR OPTICAL WITNESS SAMPLE #1

MgF_2 WAS NOT PROTECTED WITH A WINDOW DURING EXPOSURE

ORIGINAL PAGE
COLOR PHOTOGRAPH



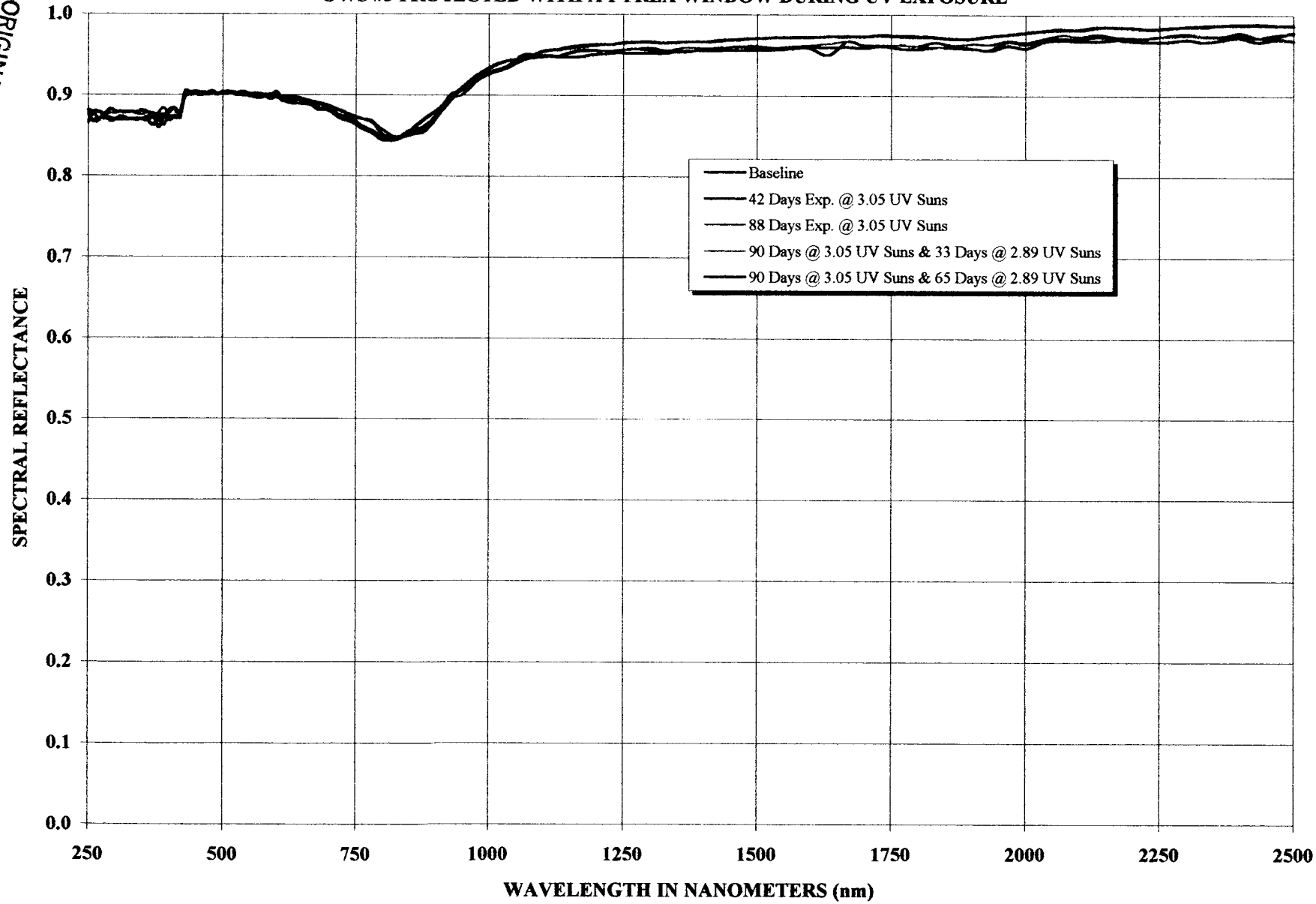
File: OWS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

OPTICAL WITNESS SAMPLE #3 - LPSR DATA

BASELINE VS 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS, ALPHA=0.094 BEFORE VS 0.087 AFTER EXPOSURE

OWS #3 PROTECTED WITH A PYREX WINDOW DURING UV EXPOSURE

ORIGINAL PAGE
COLOR PHOTOGRAPH

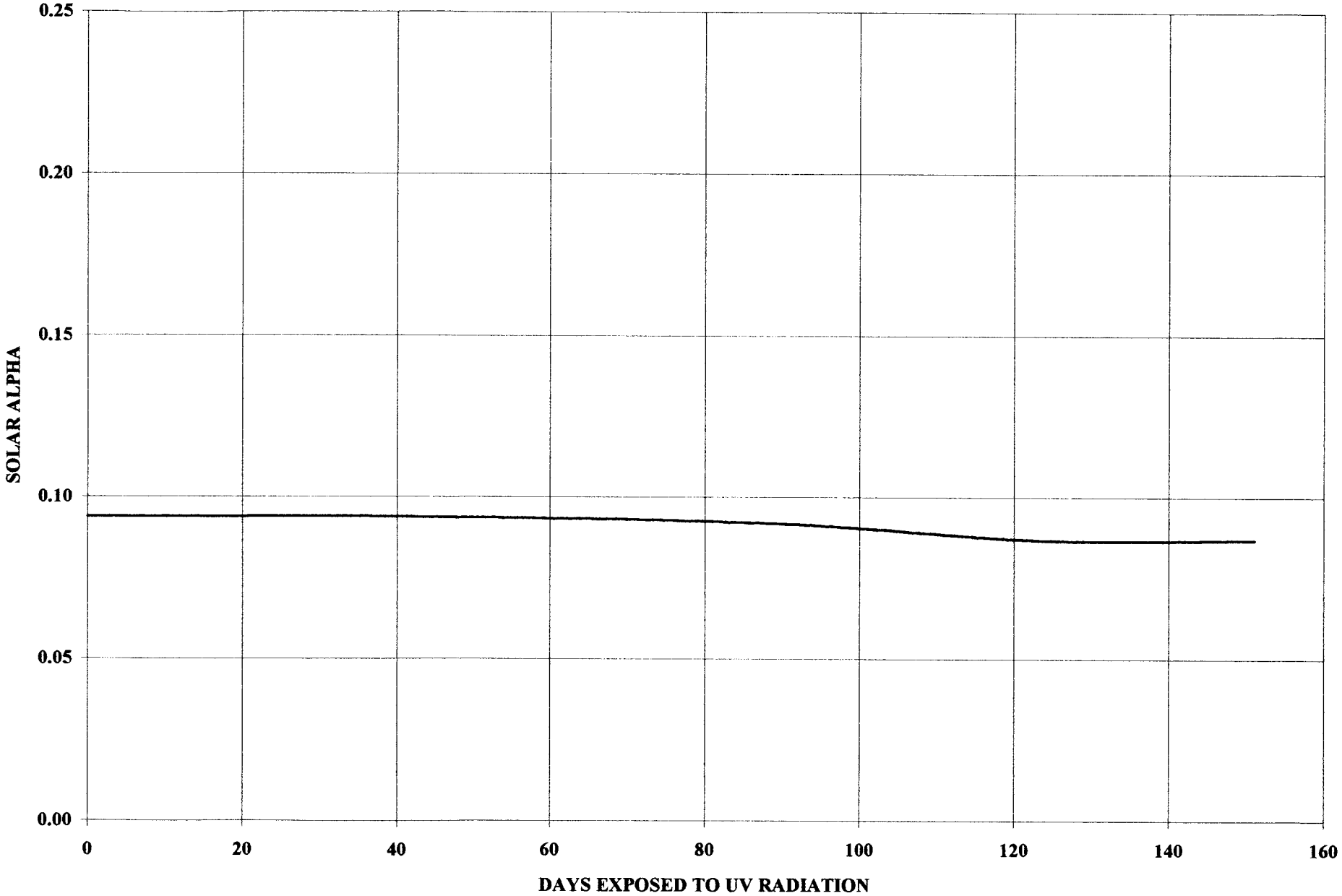


Optical Witness Sample #3 Before and After Exposure.

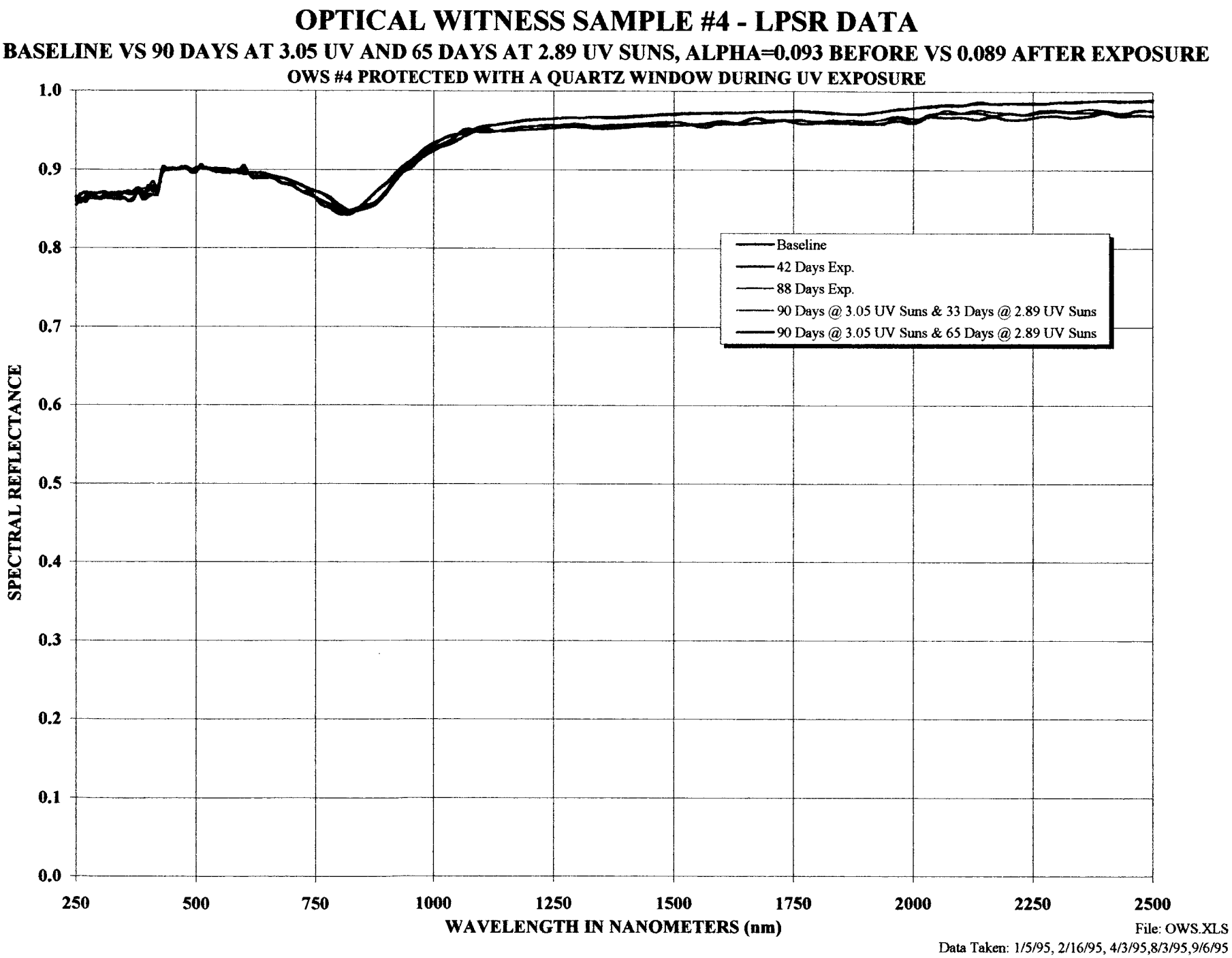
File: OWS.XLS
Data Taken: 1/5/95, 2/16/95, 4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR OPTICAL WITNESS SAMPLE #3

MgF_2 #3 WAS PROTECTED WITH A PYREX WINDOW DURING UV EXPOSURE



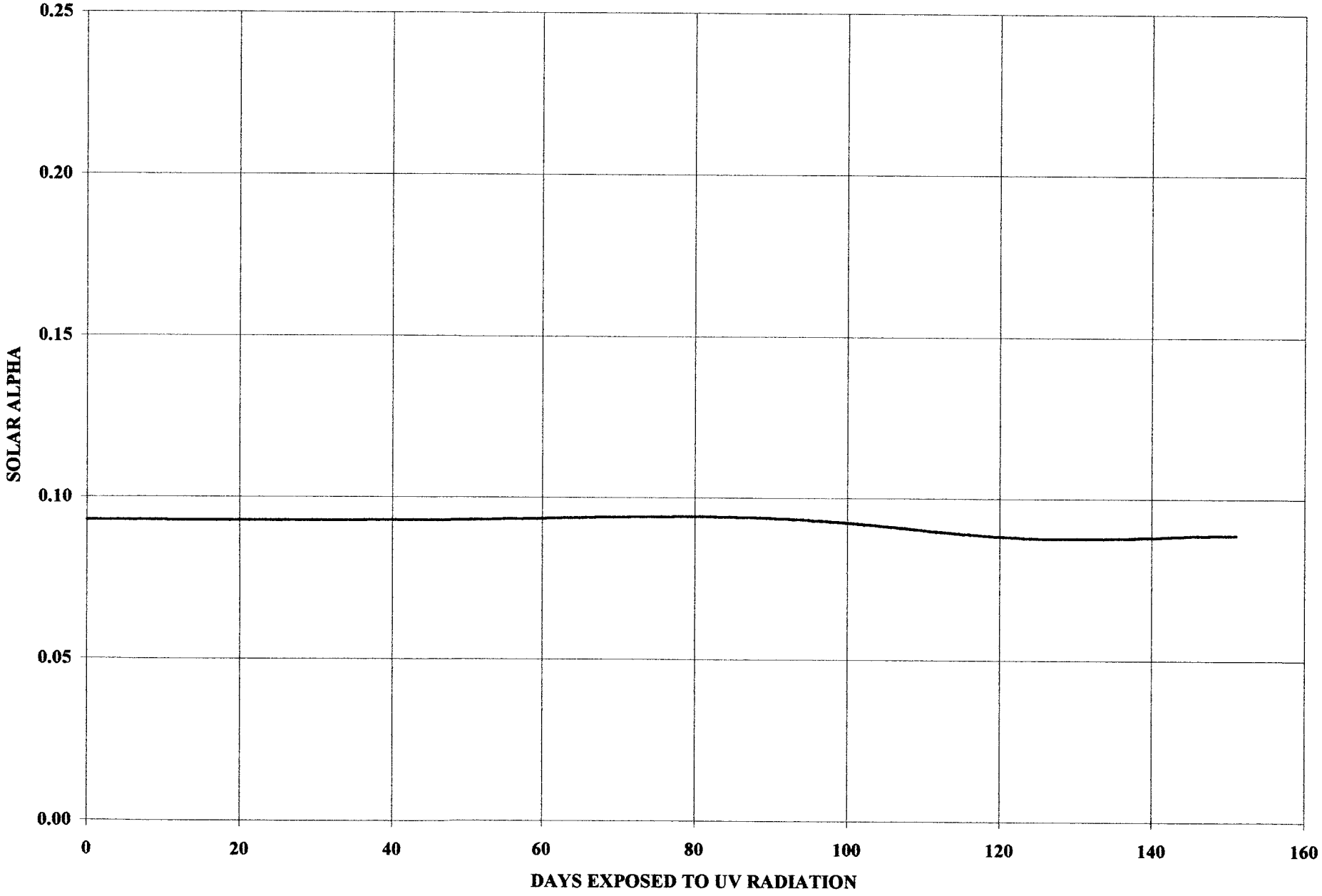
File: OWS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95



Optical Witness Sample #4 Before and After Exposure.

CHANGE IN SOLAR ALPHA FOR OPTICAL WITNESS SAMPLE #4

OWS #4 WAS PROTECTED WITH A QUARTZ WINDOW DURING UV EXPOSURE



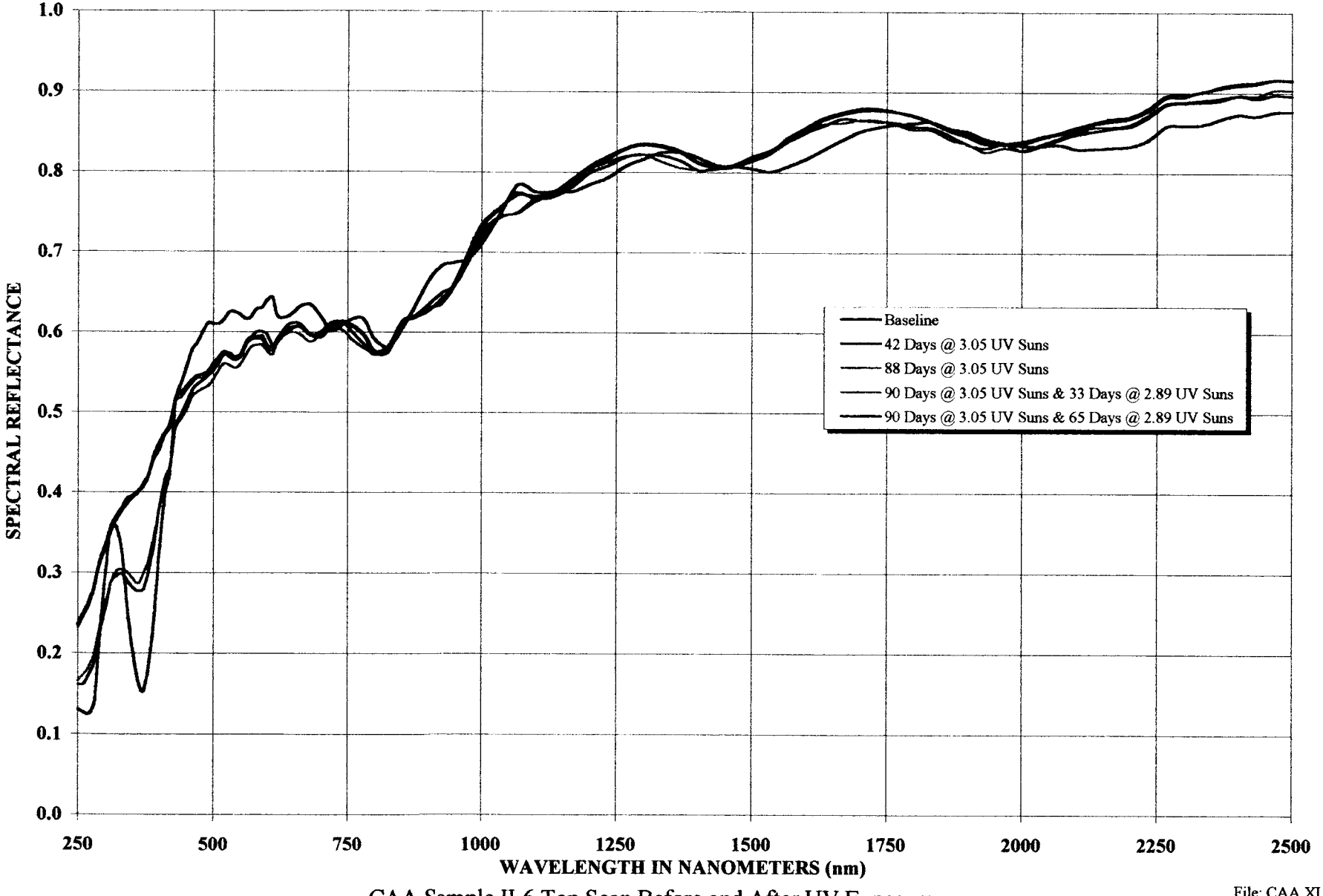
File: OWS.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

ORIGINAL PAGE
COLOR PHOTOGRAPH

CHROMIC ANODIZED ALUMINUM SAMPLE II-6

BASELINE VS 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS, ALPHA=0.362 BEFORE VS 0.356 AFTER EXPOSURE

TOP SCAN OF CAA PLATE

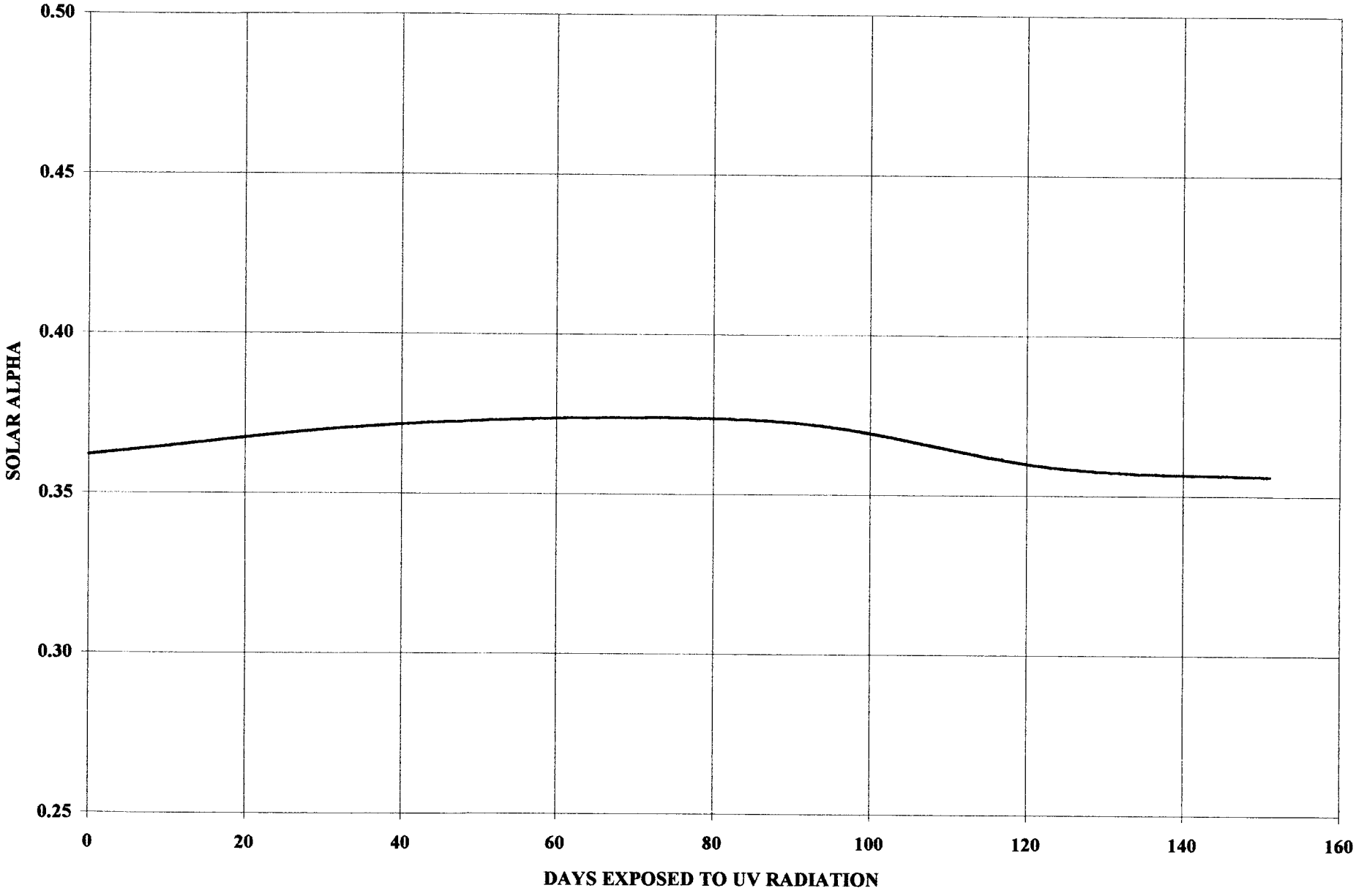


CAA Sample II-6 Top Scan Before and After UV Exposure.

File: CAA.XLS
Data Taken: 1/5/95, 2/16/95, 4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR CHROMIC ANODIZED ALUMINUM SAMPLE II-6

TOP SCAN OF CAA PLATE



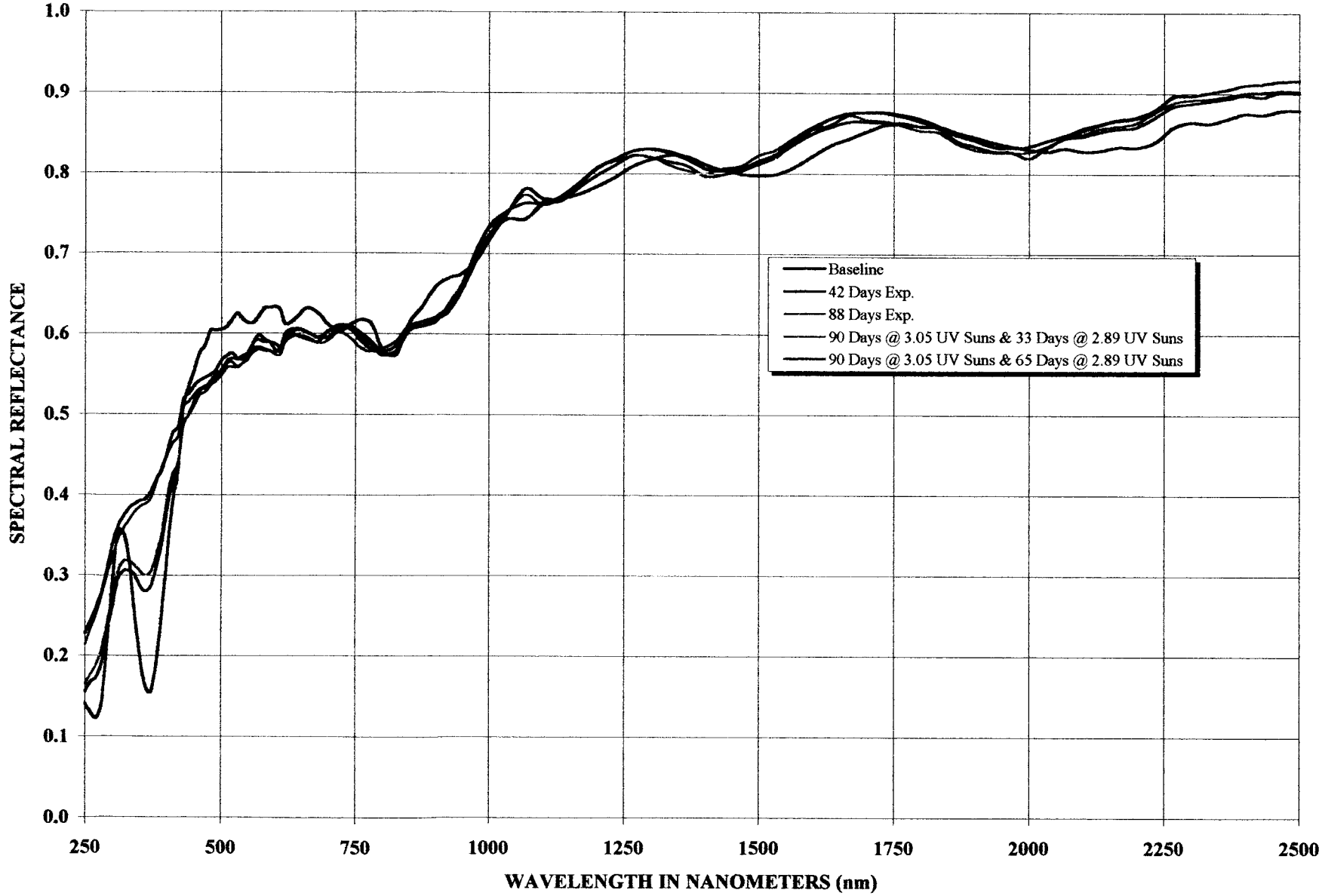
File: CAA.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

CHROMIC ANODIZED ALUMINUM SAMPLE II-6

BASELINE VS 90 DAYS AT 3.05 UV AND 65 DAYS AT 2.89 UV SUNS, ALPHA=0.364 BEFORE VS 0.358 AFTER EXPOSURE

CENTER SCAN OF CAA PLATE

ORIGINAL PAGE
COLOR PHOTOGRAPH

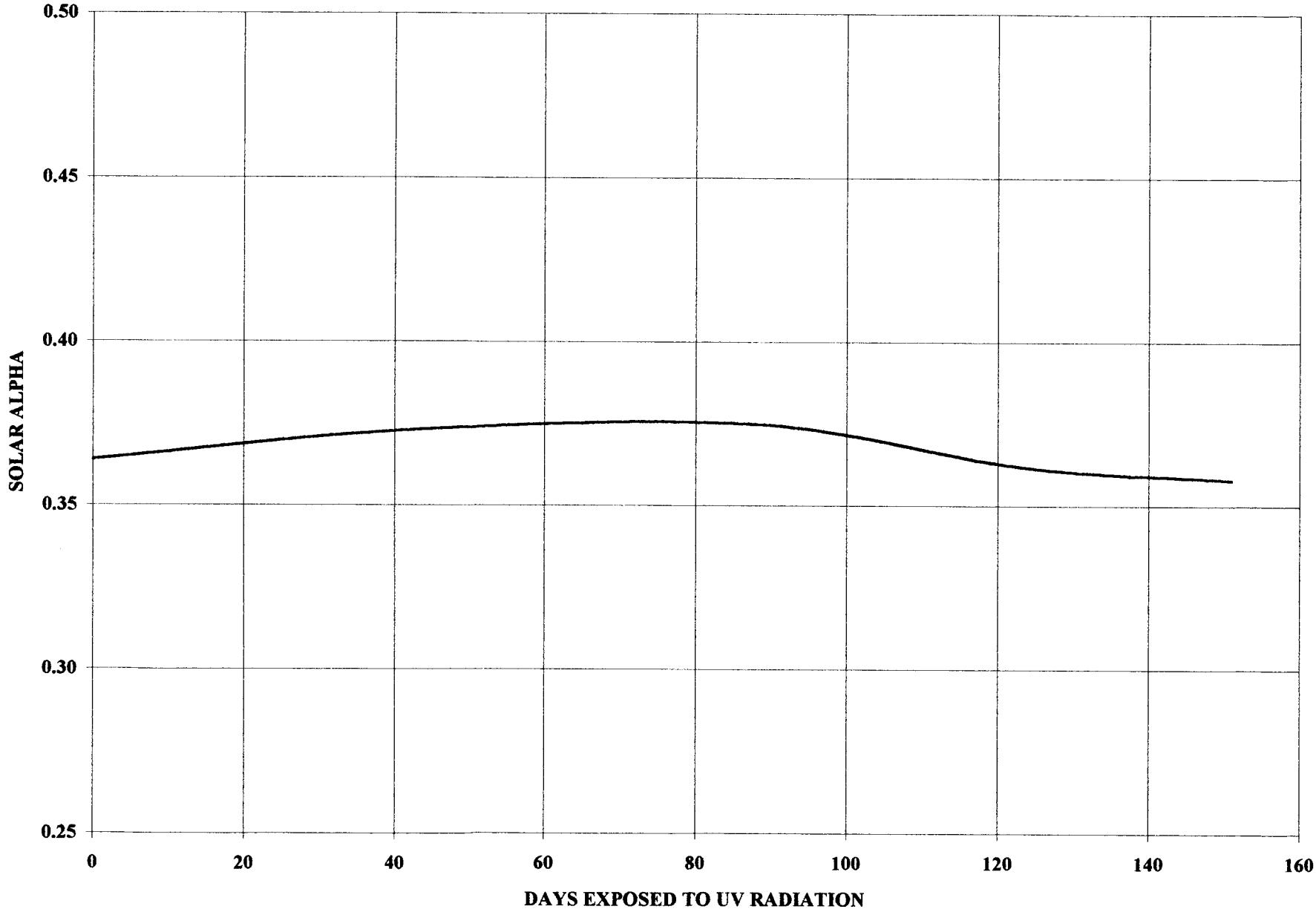


CAA Sample II-6 Center Scan Before and After UV Exposure.

File: CAA.XLS
Data Taken: 1/5/95, 2/16/95,4/3/95, 8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR CHROMIC ANODIZED ALUMINUM SAMPLE II-6

CENTER SCAN OF CAA

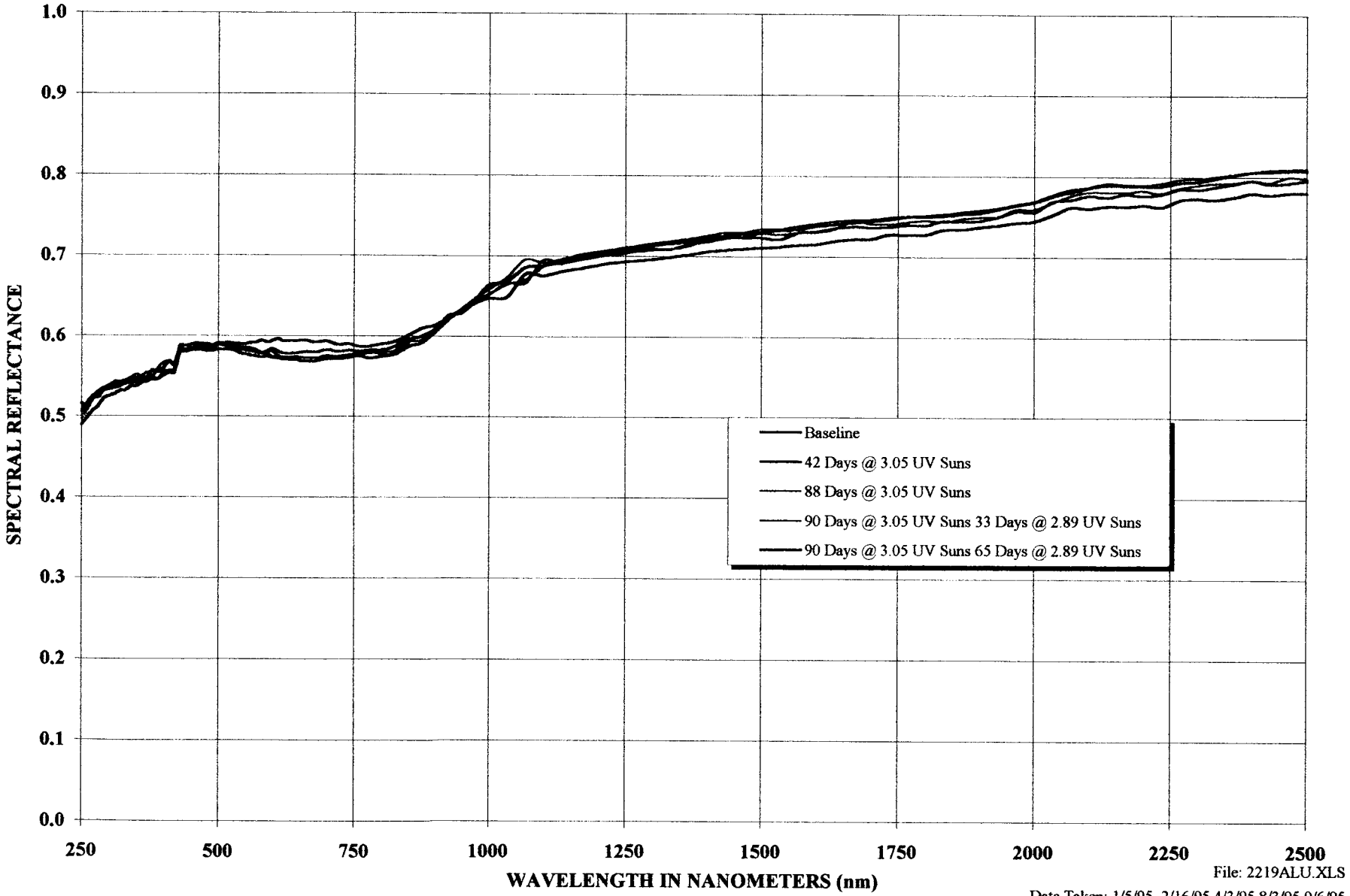


File: CAA.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

2219 ALUMINUM SAMPLE #3

BASELINE VS 90 DAYS AT 3.05 UV 65 DAYS AT 2.89 UV SUNS, ALPHA=0.375 BEFORE VS 0.375 AFTER EXPOSURE

2219 AL #3 WAS NOT PROTECTED WITH A WINDOW DURING UV EXPOSURE



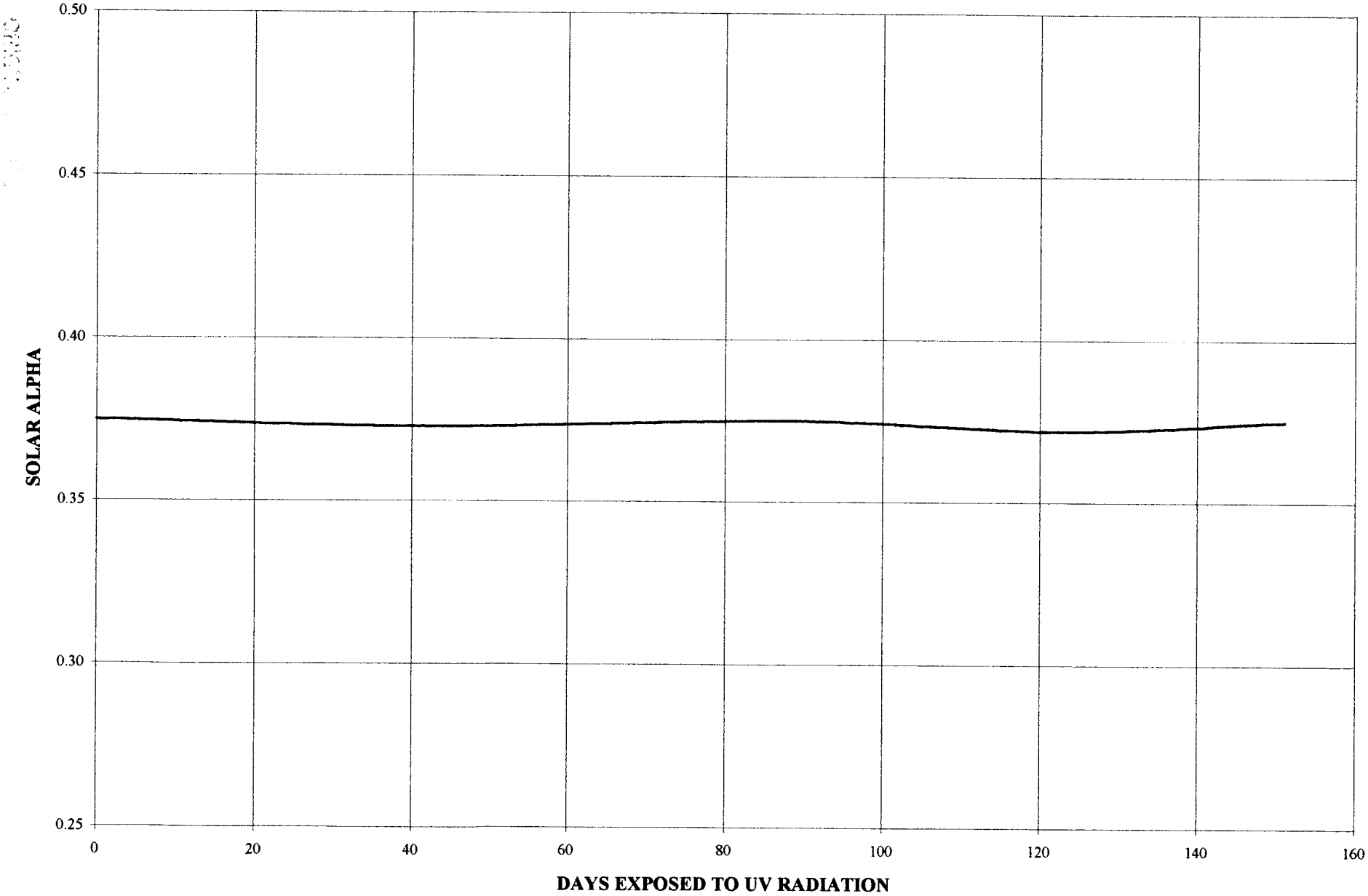
File: 2219ALU.XLS

Data Taken: 1/5/95, 2/16/95,4/3/95,8/3/95,9/6/95

2219 Aluminum Sample #3 Before and After UV Exposure.

CHANGE IN SOLAR ALPHA FOR 2219 ALUMINUM SAMPLE #3

2219 AL #3 WAS NOT PROTECTED WITH A WINDOW DURING EXPOSURE

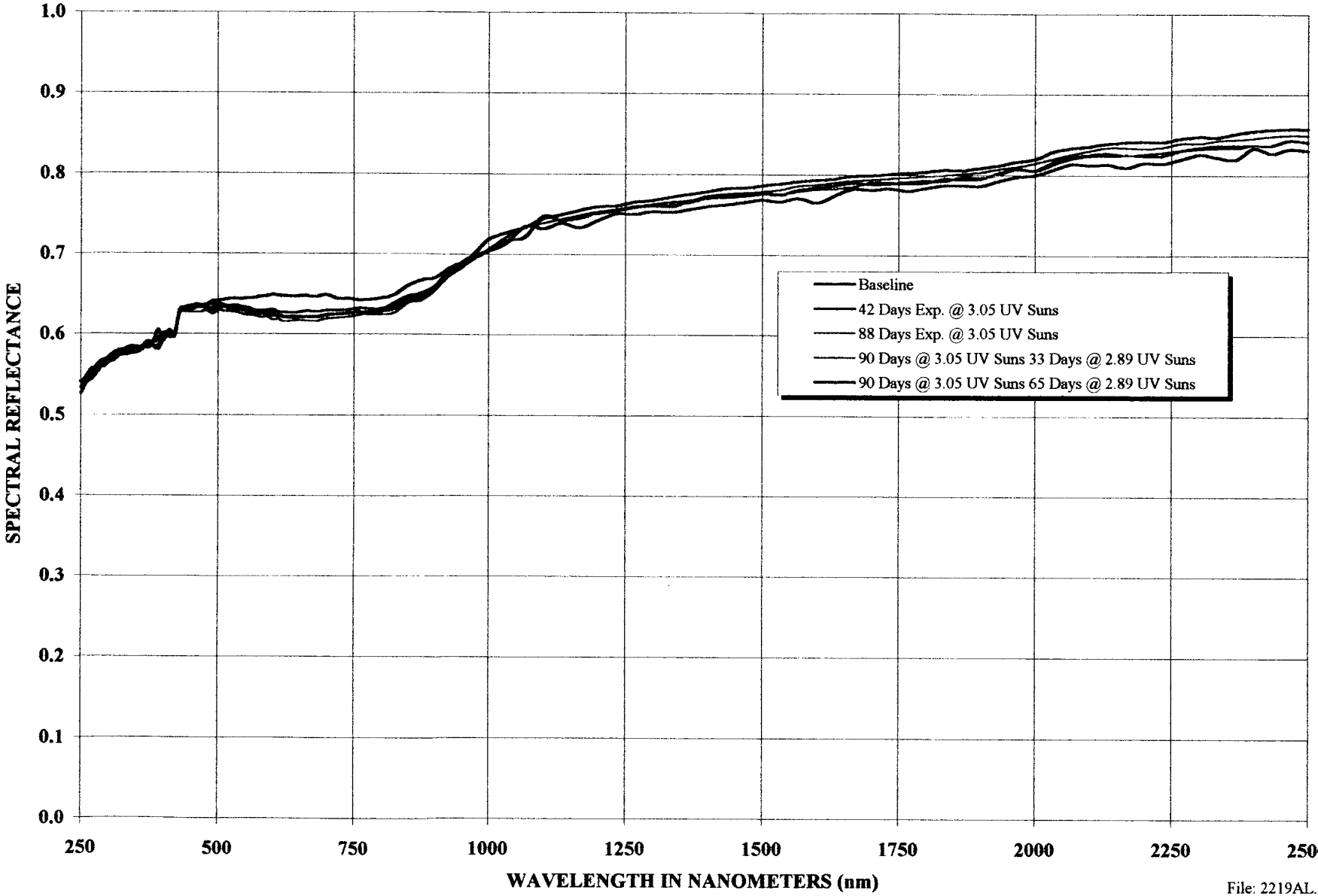


File: 2219ALU.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95

2219 ALUMINUM SAMPLE #4

BASELINE VS 90 DAYS @3.05 UV 65 DAYS 2.89 UV SUNS, ALPHA=0.322 BEFORE VS 0.324 AFTER EXPOSURE

2219 AL #4 WAS NOT PROTECTED WITH A WINDOW DURING UV EXPOSURE



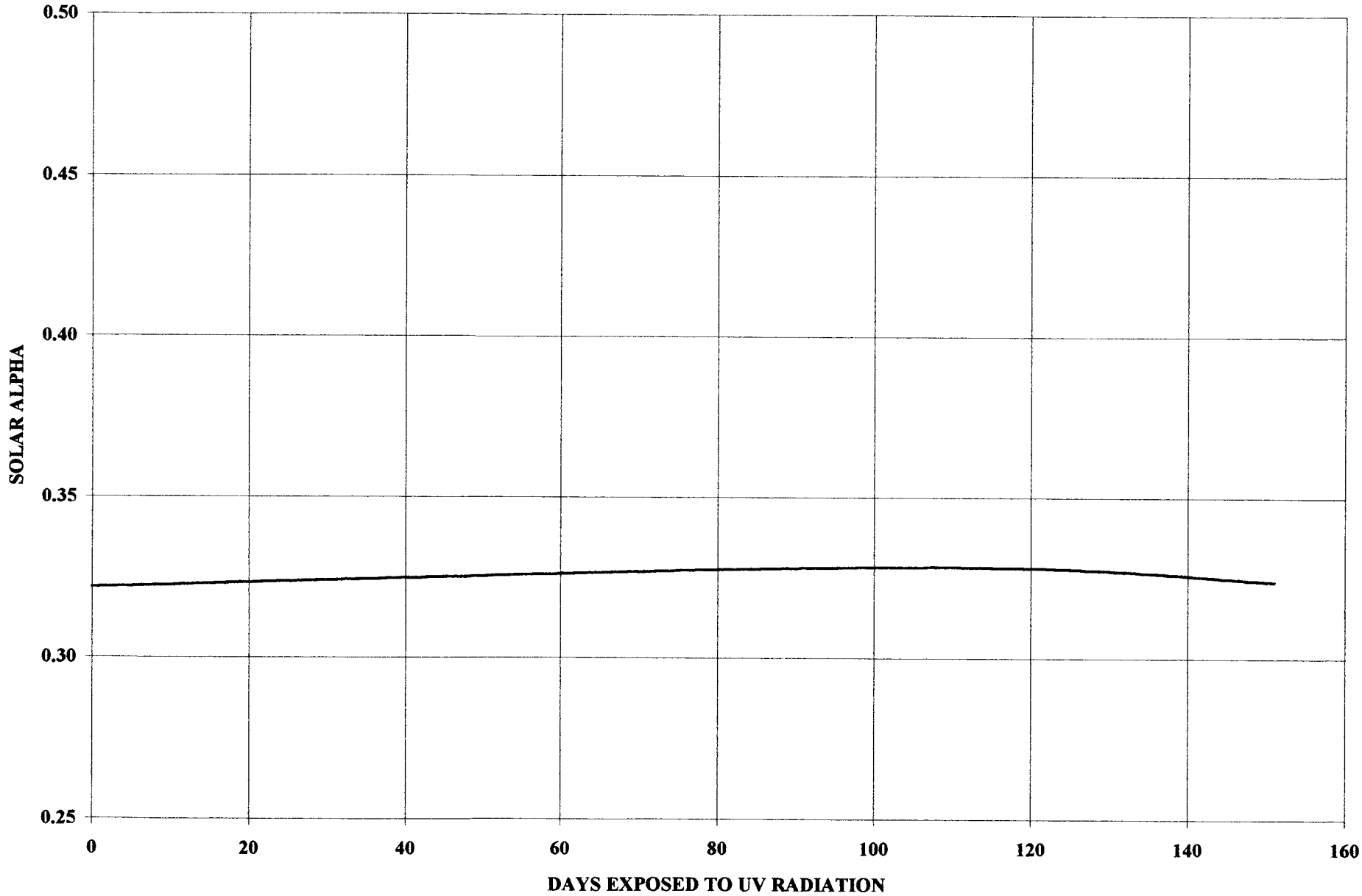
2219 Aluminum Sample #4 Before and After UV Exposure.

File: 2219AL.XLS

Data Taken: 1/05/95, 2/16/95, 4/3/95,8/3/95,9/6/95

CHANGE IN SOLAR ALPHA FOR 2219 ALUMINUM SAMPLE #4

2219 AL WAS NOT PROTECTED WITH A WINDOW DURING EXPOSURE



File: 2219ALU.XLS
Data Taken: 1/5/95,2/16/95,4/3/95,8/3/95,9/6/95