N91-21345

NCTM of Liquids at High Temperatures using Polarization Techniques

S. Krishnan, J.K.R. Weber, P.C. Nordine, and R.A. Schiffman,
Intersonics Incorporated, 3453 Commercial Ave, Northbrook, Il.

ABSTRACT

Temperature measurement and control is extremely important in any materials processing application. However, conventional techniques for non-contact temperature measurement (mainly optical pyrometry) are very uncertain because of unknown or varying surface emittance. Optical properties like other properties change during processing. A dynamic, in-situ measurement of optical properties including the emittance is required. Intersonics is developing new technologies using polarized laser light scattering to determine surface emittance of freely radiating bodies concurrent with conventional optical pyrometry. These are sufficient to determine the true surface temperature of the target.

Intersonics is currently developing a system called DAPP, the Division of Amplitude Polarimetric Pyrometer, that uses polarization information to measure the true thermodynamic temperature of freely radiating objects. This instrument has potential use in materials processing applications in ground and space based equipment. Results of thermophysical and thermodynamic measurements using laser reflection as a temperature measuring tool will be presented. The impact of these techniques on thermophysical property measurements at high temperatures will be discussed.

RESULTS: The results presented at the workshop are summarized in the next four pages. The first figure lists the various materials that have been studied in the solid, liquid and undercooled states. The second slide presents illustrates the accuracy of the technique by comparison of data with that obtained by DeVoss on tungsten. It can be seen that the accuracy is about 1% in the value of the spectral emissivity. The third slide illustrates the temperature dependence of the spectral emissivity for liquid platinum and the last slide shows recent preliminary results on solid and liquid niobium.

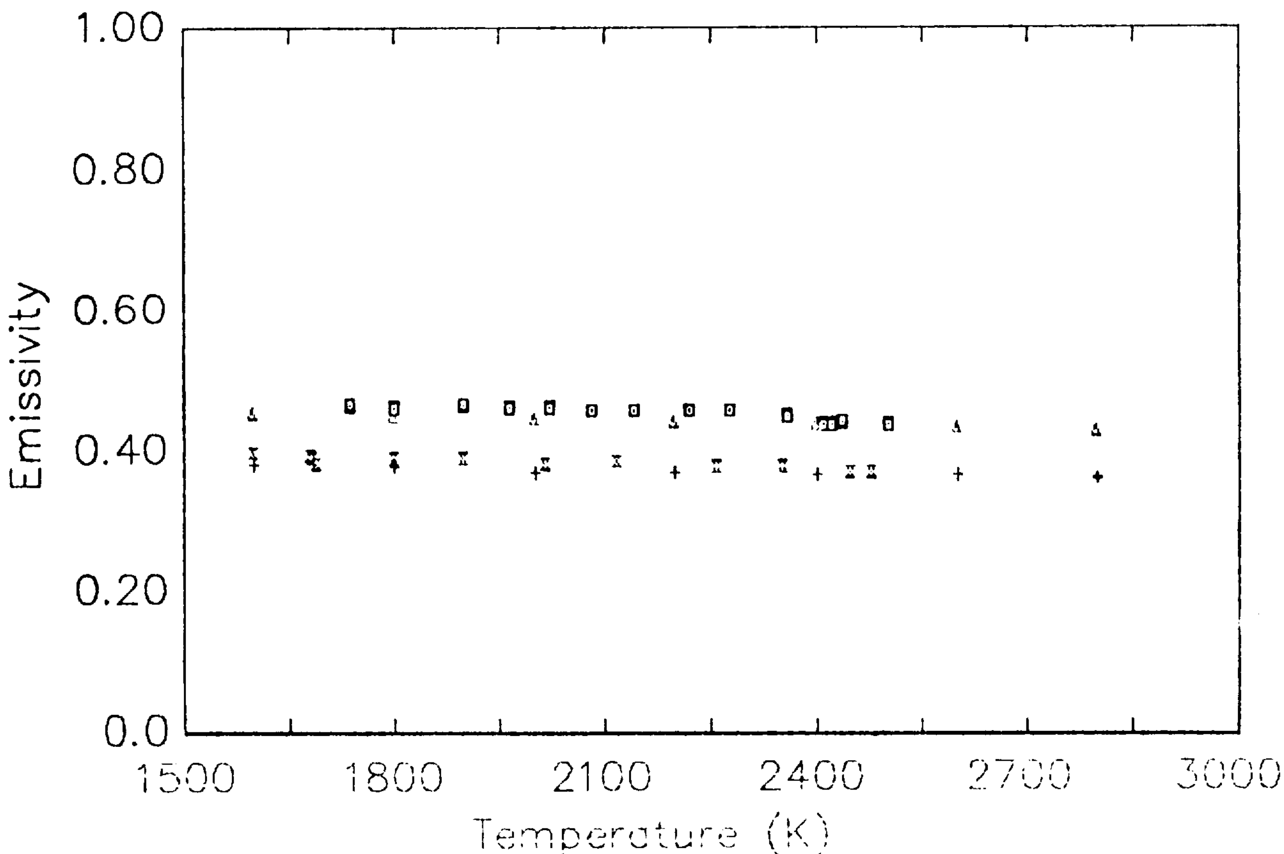
CONCLUSIONS: Extremely accurate (1%) spectral emissivities and optical properties of various materials at high temperature can be obtained using polarization techniques. The technology has been successfully applied to solids, liquids, and undercooled liquids for emissivity and true temperature measurement. The technique has been developed mainly for containerless processing for solids and liquids and Intersonics is currently developing the DAPP, the Division of Amplitude Polarimetric Pyrometer for the NASA Microgravity Sciences Program.

Materials whose optical properties have been studied using Polarization Techniques include:

SOLIDS: Si, Ti, Ir, Nb, Mo, Ta, V, Pd, Pt, W, WC, TaC, C(graphite)

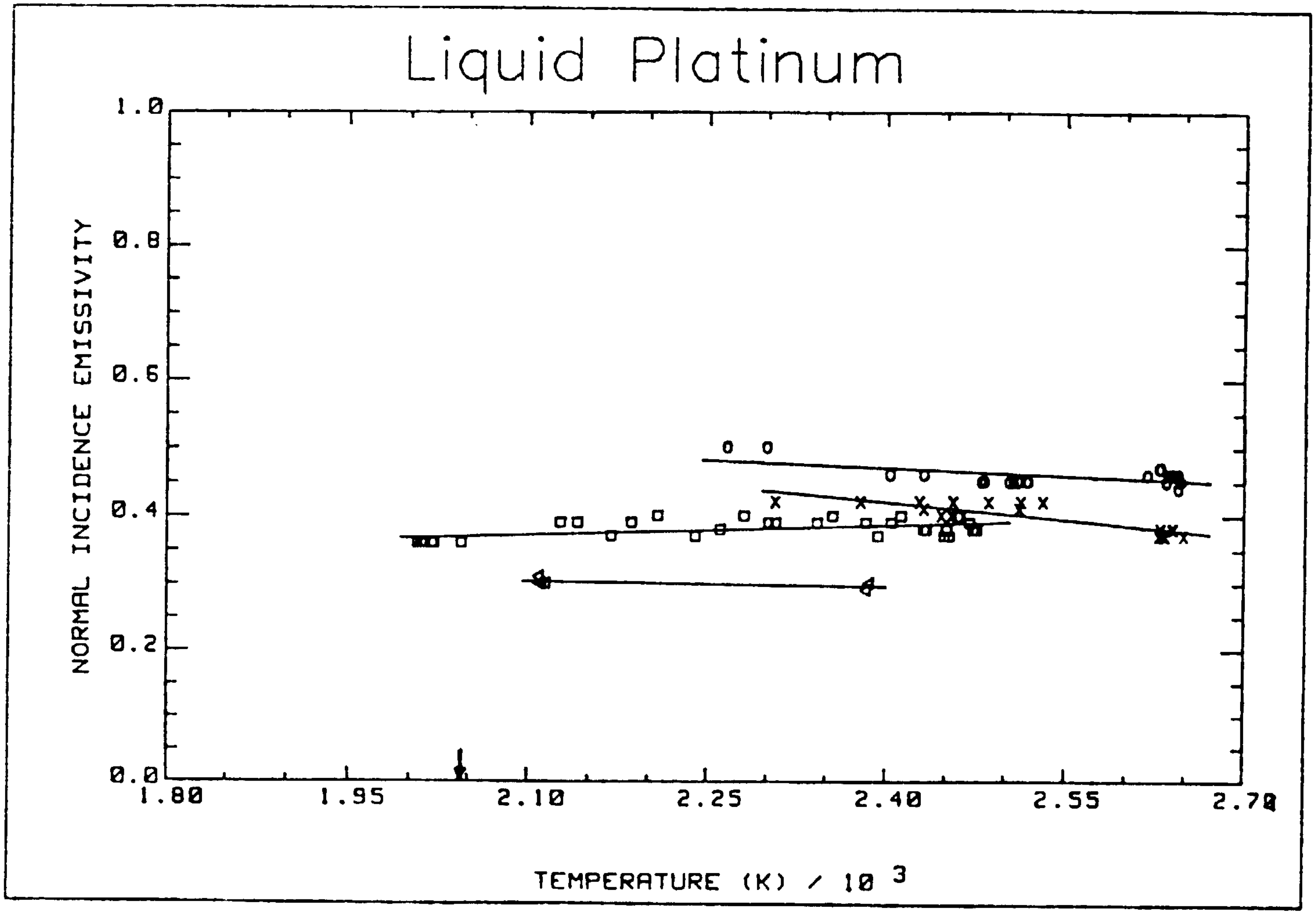
LIQUIDS: Si, Cu, Ag, Au, Ni, Pd, Pt, Zr, Al, Ti, Nb

UNDERCOOLED: Si, Pt, Nb, Zr, Pd



The spectral emissivity of tungsten at λ = 1064 (▫) λ = 633 nm (▫) as a function of temperature. The data measured by De Vos at 1064 (+) and 633 nm (△) are shown for comparison.

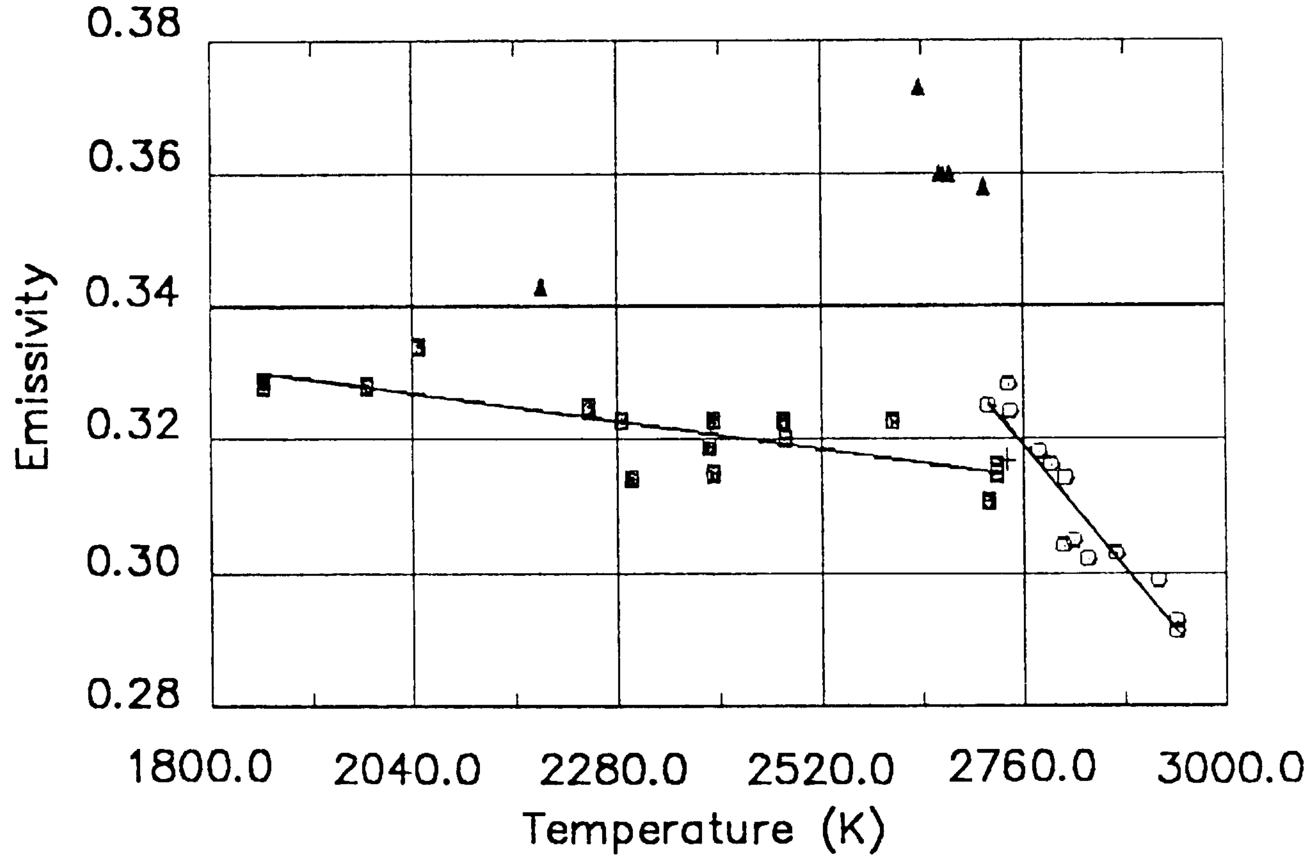
ORIGINAL PAGE IS
OF POOR QUALITY



Normal incidence spectral emissivity of liquid platinum as a function of temperature at 1064 (△), 633.8 (□), 514.5 (X), and 488 nm (O). Solid line represents the least squares fit to the data. Melting point indicated by arrow.

INTERSONICS
INCORPORATED

The normal spectral emissivity of Niobium as a function of temperature at 0.6328 μm.



○ – Liquid Niobium ■ – Solid Niobium ▲ – Solid Niobium before clean up
+ – Values at Tm and 0.65 μm (D. W. Bonnell)

D3324.DWG