Temperature and Wavelength Dependences of the Normal Spectral Emissivity of Cu in the Liquid and Solid Phases

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We have been developing non-contact laser calorimetry using an electromagnetic levitator under a dc magnetic field for measuring the heat capacity, emissivity and thermal conductivity of metallic melts [1-3]. In the measurement, the normal spectral emissivity is necessary data to know the laser absorptivity of the melts. The temperature and wavelength dependences of the emissivity of materials at high temperature are also important for temperature measurement using a pyrometer. However, determination of the precise value is still an interesting subject, because reducing the light contamination is experimentally difficult.

In the present study, we have succeeded in protecting the sample's radiation from the strong light radiated from an infrared furnace and other stray light sources inside it by using a boron nitride cylinder and an efficient optical alignment with lenses and an aperture. An optical spectroscope was calibrated using radiation of a quasi-black body, and then the radiance of Cu was measured using exactly the same optical system. The emissivity of Cu was determined by dividing the Cu radiance by the black body radiance determined by Planck's law in the 900-1250 ºC temperature range and 600-1100 nm wavelength range. The emissivity value shows a negative dependence with wavelength. The emissivity values at 650 nm wavelength are derived to be around 0.1 and 0.15 for solid and liquid Cu, respectively. The value is almost constant with temperature in each phase, but it discontinuously increases at the melting point. The value of the emissivity and its temperature and wavelength dependences are in reasonably good agreement with the published literature data [4].

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