Measurement of metals density in solid and liquid states during microsecond pulse heating

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Fast electrical pulse heating is a prominent technique for investigation of refractory metals at high temperatures. Meanwhile, some properties of such materials are still insufficiently investigated at this temperature region. For vanadium such properties as density change during melting is of special interest. In the present paper, we describe a technique for investigation of the thermal expansion of refractory materials at high temperatures and in the melting region by pulse electrical heating [1]. The experimental method consists in fast heating of the wire sample up to the melting temperature and above in a time of about 50–150 μs due to homogeneous volumetric heat release when the electric current pulse passes through it. Heating is carried out under isobaric conditions at a static pressure of buffer inert gas (Ar) of about 5 MPa. The input energy or enthalpy change can be determined by measuring the current and the voltage drop between the potential probes in the central part of the sample. Temperature measurements are performed by a two-channel optical pyrometer that implements the spectral ratio method. Thus, by measuring the surface temperature of the sample during the experiment, current and voltage, one can determine the dependence of the enthalpy change, as well as the heat capacity. The obtained thermal expansion coefficients of vanadium in solid and liquid states can be useful both for theoretical studies in constructing wide-range equation of state for refractory metals and for solving the problems of high-temperature engineering.

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