Study of thermal expansion of substances by microsecond pulse electric heating method

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This paper deals with the technique of measuring the thermal expansion of substances in a microsecond experiment. The error of measuring the thermal expansion of refractory metals at high temperatures has been estimated. To study the thermophysical properties of matter, the method of Joule heating of electrically conductive substances in the microsecond range has been experimentally realized. A conductive sample is heated by means of a high-density current pulse lasting several tens of microseconds, and such parameters as current through the sample, potential difference at the ends of the sample, and brightness temperature of the material are measured during the duration of the experiment. In addition, using a high-speed camera, shadow photography is performed to directly measure the thermal expansion of the material. To obtain the linear coefficient of thermal expansion (LCTE), a program in Python environment was developed, which allows from the analysis of gray digital images of the sample to determine the boundaries of the sample on each frame in automatic or manual mode. From the comparison of the diagrams at room temperature and in the liquid phase, the LCTE is calculated taking into account the lateral displacements of the sample and the density of matter from temperature is calculated. The error is estimated taking into account the errors of the boundary detection algorithm, lateral displacement of the sample relative to the axis and optical distortions of shadow photography. The obtained measurements were carried out with hafnium (Hf), niobium (Nb) and platinum (Pt) metals.