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Laser optoacoustic study of near-critical states and phase transitions in metals

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Pulsed laser optoacoustic technique is used for generation and study of near-critical states and phase transitions in metals. Metal surface is confined by a layer of transparent dielectric. In this case the efficiency of pressure generation is much greater than in case of the free surface so it is possible to achieve states of metals with relatively high thermodynamic parameters: P $\sim 10^4$ atm and T $\sim 10^4$ K with a table-top laser system. The experimental setup for simultaneous measurements of pressure, temperature and reflectivity of metal surface with nanosecond temporal resolution was assembled. Q-switched Nd:YAG laser with pulse duration $\sim$ 10 ns and pulse energy $\sim$ 1 J was used. Pressure was measured using $LiNbO_3$ piezo-transducer. Temperature was obtained with optical pyrometer. Lead and mercury were chosen as test metals. Pressure pulses up to 1 kbar in lead and up to 7 kbar in mercury (with T $\sim$ 2400 K - super-critical area of the phase diagram for Hg) were obtained. The curve of laser heating process in P-T coordinates was plotted. The measurements of optical properties showed considerable decrease of surface reflectivity both for lead and mercury at high laser fluences due to increase of temperature and density decrease.