Spatial distribution of thermal pressure in a laser-heated diamond anvil cell

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Temperatures profiles in a laser heated diamond anvil cell are characterized not only by high peak temperatures but also very steep temperature-gradients. The combination of these leads to the generation of a spatially non-uniform thermal pressure that remains difficult to predict in a quantitative way. Models derived from the solution to the thermal stress tensor[1, 2] are formally rigorous, but their application is complicated by the lack of reliable data on the temperature dependence of the Lamé constants. Also their predictions are to some extent in contradiction to experimental results, especially at the edge of the hot spot and/or sample chamber. We present here thermal pressure models based on geometric restrictions on the sample's volumetric thermal expansion. These models, simulating maximum and minimum thermal pressures, successfully bound experimental pressure profiles from laser heated samples of silver iodide and San Carlos olivine, taking into account a 0.6%-0.8% increase in the radius of the confining gasket. The trend for the maximum pressure model to mimic within one standard deviation the experimental data hints to the fact that the (semi-)isochoric effect dominates the experimentally observed thermal pressure over the gradient-induced relaxation effects. We use our simple model to investigate the dependence of the expected thermal pressure on the variation of thermal expansion, Grueneisen parameter, relative size of hot spot to gasket hole and relative size of sample to pressure medium.

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