Nuclear Resonance Measurements in the Laser Heated Diamond Anvil Cell

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Laser heating inside the diamond anvil has already been used in high-pressure science for more than five decades, to study properties of materials *in situ*, simultaneously at high temperature and high pressure. The laser heated diamond anvil cell (LHDAC) technique has found numerous applications in mineral physics and high-pressure chemistry, physics, Earth and material sciences.

At synchrotron light source facilities, many beamlines working with samples at high pressure have coupled LHDAC with different techniques, such as X-ray diffraction, Non-resonant Inelastic X-ray Scattering (NIXS) and X-ray Absorption Near Edge Structure spectroscopy (XANES) showing the versatile nature and popularity of the technique. More specifically for nuclear resonant scattering beamlines, the LHDAC technique has found use Nuclear Inelastic Scattering (NIS)[1,2], Nuclear Forward Scattering (NFS)[3] and Synchrotron Mössbauer Source (SMS)[4,5] experiments. Over the years, the laser heating system at the Nuclear Resonance Beamline (ID18) of the ESRF has been employed for experiments at high pressures at temperatures producing important results for geoscience[6,7].

In addition to continuous-wave heating, pulsed laser heating has the advantage of achieving significantly higher temperatures due to the concentration of high laser power in a short impulse. The repetitive heating and cooling of the sample makes time an extra variable in addition to pressure and temperature, which is not possible with continuous-wave laser heating, allowing the possibility of time-resolved measurements.

Recently, a scheme was developed at ID18, allowing for fully time-resolved measurements of either SMS or NIS of the sample while pulse laser heating at high pressures. The proof-of-principle measurements reveal the modulated displacement of the sample inside the pressure chamber while pulsed heating, creating the possibility for a new field of research.

References:

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