MS27-1-7 Temperature mapping, beam shaping and indirect laser heating in diamond anvil cells on the PSICHE beamline, synchrotron SOLEIL

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Abstract

The laser heated diamond anvil cell (LHDAC) technique is widely used to generate temperatures of more than several thousands of K for pressures reaching tens and even hundreds of GPa. It is very common on synchrotron beamlines over the world, allowing for in situ studies of phase transitions, thermoelastic properties of new materials, etc. The X-ray micro-focused beam dimensions are generally perfectly compatible with the hot spot dimensions (~10/20 µm in diameter).

Despite this popularity, this technique generates high radial temperature gradients, that are detrimental for several reasons: 1/ they generate chemical diffusion (Soret effect) that are very problematic in the case of chemically complex samples; 2/ a very small X-ray beam is required, which can be an issue when a good grain statistics is required for example in the case of X-ray diffractions; 3/ kinetics studies are very difficult to do with such gradients; 4/ the sample microstructure may be difficult to interpret correctly. Moreover, the sample is heated via a direct absorption of the laser. That often generates instabilities, particularly during melting when sample absorbance can change drastically. Of course, on many occasions the sample can't even be heated with the laser wavelength available.

For all these reasons, we have developed and implemented on the PSICHE beamline (SOLEIL) a new combination of techniques:

- Real-time sample surface temperature and emissivity mapping using an adapted 4 colour pyrometry technique [1].- Laser beamshaping: to modify the shape of the laser focused spot and to control the effect of that shape on the temperature distribution via the 4 colour pyrometry mapping.- Indirect laser heating: the technique is based on a development introduced by [2]. The sample is loaded inside a drilled boron-doped diamond (BDD) disk, opaque and laser absorber. We use here a "donut" laser shape to heat only the BDD, which thus acts as a simple heater. Direct laser absorption by the sample is minimized.

We will give details on how this combination of techniques can improve the quality of experimental results using the LHDAC technique. We will present first results and some perspectives.

References

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Temperature mapping of a BDD assembly