SCIENCES SORBONNE UNIVERSITÉ

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Master thesis proposal

Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie

Campus Pierre et Marie Curie
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Title: Melting curve determinations in metals at high pressure by combined laser acoustics and laser-heated diamond anvil cell

Keywords: melting curve, high pressure, high temperature, laser acoustics

Scientific description: Melting properties at high pressure are of particular importance for understanding of the solid-liquid phase transition in high-pressure physics, material sciences, and geophysics. In particular, the study of melting under compression is important for improving the knowledge of planetary interiors, since most of the metallic cores of terrestrial planet are at least partially, if not fully molten.

In recent years, the amount of available experimental data on melting at high pressure has increased considerably thanks to the use of laser-heated diamond anvil cells. In situ melting diagnostics are nowadays largely based on the use of synchrotron techniques (mostly x-ray diffraction and x-ray absorption), which, however, make these studies extremely costly and hardly compatible with systematic investigations.

We thus propose to use an innovative laboratory method that combines femtosecond laser acoustics with laser-heated diamond anvil cell. As both optical reflectivity and the sound velocity highly depend on the liquid vs. solid nature of the specimen, and even a small fraction of melt can largely influence such physical properties, ultra fast laser acoustics stems as very powerful melting diagnostic of samples under extreme conditions.

The master student will be involved in our on going research activity and will exploit the existing unique setup at first, to establish experimental protocols on pure metallic elements of simple structure and low chemical reactivity (e.g. molybdenum, tantalum), and then, to extend this approach to iron and iron alloys, the main constituents of telluric planetary cores.

Obtained melting curves will be integrated with literature data to establish phase diagrams and to address the thermodynamics of the investigated systems. Results on iron and iron alloys will be used to constrain the temperature profiles within telluric planetary cores.

Techniques/methods in use: pump-probe laser acoustics, diamond anvil cell, laser heating
Applicant skills: Motivation for an experimental and developmental work
Industrial partnership: No

Internship supervisor(s): D. Antonangeli (daniele.antonangeli@upmc.fr; 01 44 27 52 22); F. Decremps (frederic.decremps@sorbonne-universite.fr; 01 44 27 45 16)

Internship location: SU, campus Pierre et Marie Curie, IMPMC

Possibility for a Doctoral thesis: Yes, ERC PICKLE (funding allocated)