SCIENCES SORBONNE UNIVERSITÉ

2019-2020

Master thesis proposal

Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie

Campus Pierre et Marie Curie
Tower 23 - 4th floor -23-22
Director: Guillaume Fiquet

Title: Lattice dynamics of the transition metal Ruthenium investigated by ultrafast pump-probe laser experiment in diamond anvil cell.

Keywords: Ruthenium, Transition metals, High Pressure, Picosecond acoustics, Diamond anvil cell.

Scientific description:

Ruthenium belongs to the transition metals group, which has attracted continuous attention of both physicists and chemists. Among many reasons, their unusual electronic and structural properties, which have their origin in the dominant influence of *d* electrons on the electronic structure is central.
They often exhibit pronounced phonon anomalies as a result of complex Fermi-surface geometries in conjunction with strong electron-phonon coupling, whose consistent description still provides a challenge for theoretical approaches.
However, despite such difficulties, lattice dynamics anomalies have recently been theoretically predicted in solid Ruthenium by first-principles density-functional perturbation calculations. From an experimental point of view, very few studies have been published, and no phonons measurements has (up to now) been carried out on pure Ru, mainly because technical constraints that preclude studying the elastic properties of single-crystal in laboratory.

The master student will thus be involved and deeply implicated within our group of research (MP3, IMPMC : see our website for further information), who has successfully implemented a new and original set-up (femtosecond laser acoustics) that allows sound velocity and phase diagram investigation of opaque single-crystals (including high pressure).
She/He will mainly carry out experimental works, studying the phonon dynamics of hexagonal Ru (at ambient and high pressure conditions), using a state-of-the-art time-resolved optical measurement. The main goal will be to discuss such data in order to elucidate the physical origin of pronounced phonon anomalies observed theoretically, using an experimental and consistent probe.

Techniques/methods in use: Picosecond acoustics, diamond anvil cell
Applicant skills: Experimental work, solid state physics (lattice dynamics)
Industrial partnership: N

Internship supervisor(s) (name, email, phone, webmail): DECREMPS Frédéric (frederic.decremps@sorbonne-universite.fr) and BOCCATO Silvia (silvia.boccato@upmc.fr)
Internship location: SU, campus Jussieu, tour 13, étage 3.

Possibility for a Doctoral thesis: Y