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Tuning the van der Waals gap of layered materials with high pressures

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Summary *(400 caractères maxi)*

We propose to use a diamond anvil cell to apply high pressure on a layered material or heterostructure to finely tune the interlayer distance and all the electronic/magnetic properties that are directly related to this paramater. Pressure induced changes will be probed at cryogenic temperature with optical techniques (photoluminescence, Raman scattering, reflectivity).

Detailed subject

The Grenoble High Magnetic Field Laboratory (LNCMI-G, CNRS), is a French large scale facility enabling researchers to perform experiments in the highest possible continuous magnetic field.

2D materials are a class of material extracted from 3D layered materials and offering a new playground for optoelectronics as well as for fundamental physics. This family includes metallic compounds like graphene, semiconductors like transition metal dichalcogenides, charge density wave materials as well as superconductors. In the last years, the possibility of stacking different 2D materials on top of one another to form van der Waals heterostructures has emerged. In their bulk form or in heterostructures, most of properties of layered multilayers depend on the electrostatic or magnetic coupling between the layers and should strongly depend on the magnitude of the van der Waals gap, the interlayer separation. We propose to investigate the dependence of interlayer properties on the van der Waals gap which we propose to tune by applying a large hydrostatic pressure in a diamond anvil cell. The modifications of the interlayer coupling will be traced by optical spectroscopy methods (photoluminescence, Raman scattering etc …) which are good probes for magnetism, exciton physics or to characterize a particular electronic ground state such as charge density wave of superconductivity.

Publications linked to the theme

A. Delhomme et al. 2020 2D Mater. **7** 041002

D. Vaclavkova et al., 2D Materials 7, 035030 (2020) and D. Vaclavkova et al., Phys. Rev. B 104, 134437 (2021)

Background and skills expected :

Candidates should be interested by experimental solid state physics, a background in solid state physics and in optical spectroscopy.

2D materials, van der waals heterostructures, interlayer excitons, high pressure, magnetic fields

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