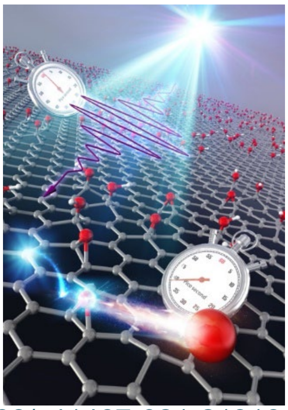
PhD (M/F) in Ultrafast electron diffraction applied to photo-induced phase transitions in morphologically tailored quantum materials

at

CNRS- IPR (Institute of Physics of Rennes), France

Short description of the project



One of the challenges in ultrafast material science is to trigger a macroscopic phase transition using ultra-short light pulse. During such transformations, several degrees of freedom couple, which gives rise to multiscale dynamics in time and space, so fast that they escape the laws of thermodynamics. Non-equilibrium science holds also great technological potential, and prominent examples exploiting the insulator to metal transitions (IMT) already include data storage devices or hardware neural networks for artificial intelligence [doi.org/10.1103/PhysRevApplied.17.014040].

In systems undergoing IMT, light excitation generates precursor states where correlations between the degrees of freedom, such as charge or lattice, are transiently modified and they evolve on complex pathways far from equilibrium. A new transformation pathway and photoinduced strain waves as *modus-opperandi*, was recently discovered in Ti_3O_5 nanocrystals [doi.org/10.1038/s41467-021-21316-y; doi.org/10.1038/nchem.670]. The importance of crystal morphology for such ultrafast transformations was then demonstarted in V_2O_3 [doi.org/10.21203/rs.3.rs-3239079/v1], but the full understanding of the driving mechanism requires further in-depth studies.

This PhD project aims to provide with robust crystallographic analysis of the phtotinduced phase transitions on unprecedented spatio-temporal scales (nanometer-femtosecond). Experiments will be performed using ultrafast electron diffraction available through collabartion with Tsukuba University and Tokyo University, on morphologicaly tailored samples. The PhD student will also be involved in ultrast xray diffraction at the European-XFEL and Japanese SACLA facility. The PhD work will also include modelling of dynamic thermo-elastic effects arising in the *ps* to *ns* time-scale range. The group at IPR hosting the PhD is expert in advanced crystallography, photoinduced phase transitions and ultra-fast phenomena, and published several breakthrough papers on these topics.

The candidates

We look for a very motivated candidate interested in working in a highly collaborative environment. The candidates should have basic knowledge and a desire to deepen their understanding in the fields of materials science and crystallography. They should be familiar with various experimental techniques such as x-ray/electron diffraction and laser spectroscopy. It is desirable for candidates to be acquainted with data processing (Python or similar) and be interested in developing experiments.

Our department

The candidate will be working at the CNRS and specifically associated to the Materials and Light Department at the Institute of Physics of Rennes under the supervision of Maciej Lorenc and Philippe Rabiller. We are a highly collaborative and international team with more than 20 researchers working in the areas of ultrafast spectroscopy, crystallography and energy conversion. Our research facilities include 4 ultrafast lasers, 2 diffraction spectrometers, sample deposition equipment as well as electrochemical capabilities. Our group has received funding by the ERC, the ANR or Rennes Metropole and the Department leads the CNRS international lab DYNACOM in partnership with the University of Tokyo.

Our department

Link to our website: https://ipr.univ-rennes.fr/en/materials-and-light-departement

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