Projet de contrat doctoral

Unité d'accueil

Institut de Physique de Rennes

Encadrement

Directeur de thèse : Maciej Lorenc (IPR)

Co- directeur de thèse : Prof. Jacek Kubicki (UAM, Poznan, Pologne)

Co-encadrant :

Sujet

Titre : "Probing photoinduced phase-transitions with femtosecond IR spectroscopy"

Mots clés OU résumé (15-30 lignes) :

The PhD project will focus on photoinduced electronic-structural phase transitions in molecular materials, whose functionalities are determined by collective and cooperative phenomena. It will addresses essential questions related to the manipulation of matter by light, and goes beyond the current principles established by femtochemistry (Lorenc, *PRL 2009*). Attaining light-control requires new experimental approaches, capable of providing accurate picture for tracking the pathways where electronic and structural degrees of freedom couple to form photoinduced phases.

This project is motivated by unequivocal identification and description of such photoinduced states and phases. To this end, various methods of pump-probe infrared (IR) spectroscopy will be adopted. For example, IR spectroscopy allows recording the formation of molecular species with a much finer resolution than electronic transition (UV-VIS) spectroscopy. It has the advantage to be very sensitive to the formation of new species with non-overlapping bands (Kubicki, *JACS 2009*; Kubicki, *JACS 2011*). Generally, the vibrational spectra of molecules in excited states show frequency shifts with respect to the ground electronic state. These shifts can be observed on the timescale of the excited state lifetime, and can be interpreted in terms of structural or electronic changes, providing significant insights into transient molecular structures. As another example, time-resolved IR spectroscopy was recently used in a study of a photoinduced phase transition of a charge-ordered insulating phase, (Fukazawa, *J. Phyc. Chem. C 2012*). The vibrational spectra recorded within the range of charge- and structure-sensitive C=C stretching modes, elucidated the nature of the new phase as being very close to that of the high-temperature metallic phase. Only through transient vibrational spectra, the gradual growth of the photoinduced mettalic phase could be discovered.

The PhD will be based at IPR-Rennes with extended stays at UAM-Poznan. The newly commissioned ultrafast broadband IR detection at UAM will be complementary to the IR-VIS ultrafast laser spectrscopies developed recently at IPR.