Etude de la dynamique des phonons dans les carbones non-graphitisables par diffusion Raman

This doctoral research will be conducted at the Interfaces, Confinement, Materials, and Nanostructures (ICMN) laboratory in Orléans-France, within the "*Interfacial Systems and Functional Carbons*" (SICF) research group. Our research specializes on the tailored synthesis and development of carbon-based materials, focusing on innovative methodologies for their functionalization and structural modification. The ICMN is renowned for its significant contributions to understanding and optimizing the structural and functional properties of carbon materials.

Among the materials developed in our laboratory, non-graphitizable carbon holds particular significance. Its unique properties make it highly sought after for various applications, including pollutant capture (gas adsorption), sodium-ion batteries, and other emerging technologies. Unlike graphitizable carbons, non-graphitizable carbon does not develop a graphitic structure, even under high thermal treatments (up to 3000°C), but exhibits locally ordered structures. A deeper understanding and control of the structural organization of these materials will enale the adjustment of their properties for targeted applications, enhancing their appeal for specific industrial uses.

Raman scattering spectroscopy has become the method of choice for studying sp^2 carbons, as it precisely reveals the subtle interactions between electrons, phonons, and defects in these materials. However, the optical response of non-graphitizing carbons remain poorly understood and is a subject of ongoing debate, particularly regarding the influence of defects on the relative intensities of Raman bands. Our previous work has established correlations between Raman responses and structural modifications (observed by X-ray diffraction), revealing the impact of mechanical processes on the evolution of certain vibrational modes. Our recent studies have demonstrated, through angle-resolved Raman spectroscopy, that the seemingly random behavior of certain Raman modes after polishing, in the case of a graphitizable carbon pyrolyzed at 2000°C, is not as random as it appears. The activation of Raman modes associated with defects is directly related to the orientation of crystallites within the material, a phenomenon amplified by the polarization of the excitation light.

In this context, the proposed thesis aims to deepen the understanding of the optical properties of non-graphitizable carbons, particularly their Raman response. The research will primarily rely on the state-of-the-art Raman spectrometer acquired by the laboratory in 2022, which offers high spatial and spectral resolution confocal imaging capabilities. The doctoral candidate will also have access to advanced techniques available at the ICMN, such as X-ray diffraction (XRD), Transmission Electron Microscopy (TEM), and Atomic Force Microscopy (AFM), to facilitate correlations between structure and optical properties, specifically focusing on phonons and material defects.

[1] M.R. Ammar et al. Spectroscopy Letters. **2011**, 44, 535
[2] M.R. Ammar, J.N. Rouzaud. JRS, **2012**, 43, 207-211
[3] O.A. Maslova et al. Physical Review B 86 **2012**, 134205-1-5
[4] Y. Hbiriq et al. Physical Review B 107, **2023**, 134305

Candidate Profile

Education: Master's degree in Materials Science, Solid State Physics, Physical Chemistry, or a related field. Candidates with a strong background in materials characterization and knowledge of carbon materials are encouraged to apply.

Thesis Details

- Location: Interfaces, Confinement, Materials, and Nanostructures Laboratory (ICMN, CNRS/University of Orléans, UMR 7374).
- Address: 1B, rue de la Férollerie, CS 40059, 45071 Orléans Cedex 2, France
- Website: http://www.icmn.cnrs-orleans.fr/
- Duration: 3 years (October 1st 2025–September 30th 2028)

Application Process

Interested candidates are invited to send their CV and cover letter via email to Mohamed-Ramzi Ammar before April 15th at mohamed-ramzi.ammar@cnrs-orleans.fr