Exploring the Electronic and Structural Properties of Tantalates and Infinite-Layer Nickelates via Electron Microscopy and X-ray Spectroscopy Approaches

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THÈSE

Mardi 22 octobre 2024 – 14h00

Amphithéâtre Blandin au LPS, bâtiment 510, Orsay

In this thesis, a combination of complementary techniques has been employed that is the scanning transmission electron microscopy (STEM)- electron energy loss spectroscopy (EELS), four dimensional (4D)-STEM, hard X-ray photoemission spectroscopy (HAXPES) and complementary ab-initio calculations and X-ray scattering experiments to elucidate the origins of the complex physics exhibited by infinite-layer (IL) nickelates and potassium tantalates ($KTaO3$). This thesis begins by exploring the origins of competing orders such as the $3a_0$ periodic charge order in IL-nickelates, observed in X-ray scattering experiments. Here, through a combined analysis with STEM-EELS, 4D-STEM and HAXPES, this particular ordering was found to be originating from a particular $\{303\}_{pc}$ ordering of oxygen vacancies in the nickelate thin-film. Further exploration resulted in the discovery of a new valence ordered and tri-component coordinated nickelate phase with the formula $A_9B_9O_{22}$, that is an intermediate between the parent perovskite and reduced IL-nickelate. Through further studies, It was found that there are highly different n-type and p-type interfaces exists in superconducting IL-nickelate samples. This non-universality of interface nanostructure in superconducting IL-nickelate samples, decoupled the interface influence and superconductivity in IL-nickelates. This generated interest in studying an oxide interface, where the interface is superconducting, and in the followed part, the superconducting 2DEGs in $AlO_x/KTaO_3$ was explored. The electronic and structural aspect of the $AlO_x/KTaO_3$ interface controlling the 2DEG was studied using STEM-EELS and HAXPES. A real space map of the 2DEG was obtained, along with indications of a significant unit cell expansion in this region. Layer resolved standing wave (SW)-HAXPES also indicated a substantial polar like displacement for the reduced Ta atoms at the interface.

Jury members :

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Vous êtes cordialement invités au pot qui suivra

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