To2Dox: Transferable 2D layers of correlated oxides

Main area: Synthesis of monolayers of non-layered compounds
Keywords: oxides, interfaces, 2D layered materials, epitaxial growth, heterostructures, defect characterization
Duration: 36 months
Total project funding: € 772.808

Abstract

To2Dox aims at fabricating and characterizing a new class of freestanding 2D layers based on correlated transition metal oxides, and their combination in multifunctional heterostructures with conventional 2D van der Waals (vdW) materials. 2D-oxide freestanding layers will harbor novel spontaneous and externally switchable collective states driven by electronic correlations which will tremendously expand the functional capabilities of current vdW materials and generate synergies with the Graphene Flagship.

The new type of freestanding correlated oxide 2D layers will be synthesized from epitaxial ultrathin oxide layers grown on sacrificial layers with atomic level control of their chemistry and structure. 2D oxide layers will be transferred and manipulated using deterministic placement methods developed for 2D vdW materials.

A strong effort will be dedicated to the characterization of the unique surface reconstructions and defect structure of these oxide layers and their functional response. The atomic, electronic, magnetic and vibrational properties of defects in 2D oxide layers will be calculated using the state-of-the-art first principles methods based on hybrid functionals.

Heterostructures combining freestanding layers of correlated oxides with vdW 2D layers will inspire a completely new generation of proximity phenomena. These will be exploited to engineer electronic groundstates with tunable responses, absent in the current vdW materials including electrically controlled topological states, spin-orbit induced spin textures or topological superconductivity.

Our project will realize the hybridization of two emerging fields: oxide interfaces and 2D vdW materials. It will synergize a very large palette of complementary expertise covering all the research methods to achieve project objectives. The consortium includes experts in the epitaxial growth of oxides with atomic control of the interfaces and in their functional characterization, in oxides defects characterization and manipulation, in the fabrication of planar perpendicular devices including proximity interactions and in the synthesis, manipulation and characterization of 2D vdW materials.

Regarding the expected impact of To2Dox, the project relies on a transformative effort for expanding functionalities of 2D materials by incorporating the robust collective states of a completely new family of layered freestanding materials: the 2D oxide materials. On the other hand, it is committed to the study and realization of a novel technological platform based on the oxide nanotechnology for exploiting novel quantum states in correlated oxides. Furthermore, from the applied perspective, collective orders switchable by an external field could inspire new strategies for new device concepts towards future atto-Joule low voltage logic surpassing the (energy) limitations of the current CMOS semiconductor technology.

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