Functional oxides grown by MBE

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Molecular beam epitaxy (MBE) is a well-known advanced epitaxial growth technique for semiconductors [1], but is barely used for complex oxides despite original opportunities [1-2]. In this invited talk, a brief description of the MBE technique will be firstly presented. The main MBE-growth *challenges* for complex oxides and the corresponding current *technical advances*, as well as the unique *opportunities* compared to other growth techniques, will be explained. The state-of-the-art taken from literature of oxide films grown by MBE will be exposed, of interest for various application fields (nanoelectronics, photonics and microenergy).

Then, the oxide MBE chamber available at INL in the Nanolyon technological platform will be presented (Fig. a). Some distinctive results of epitaxial oxide heterostructures grown at INL will then be given for each category, based on the advantages of the MBE technique: quaternary *solid solutions* (Fig. b), ultra-short period *superlattices* (Fig. c) down to the very monoatomic layers control (Fig. d), and monolithic *integration on semiconductors* using passivation strategies (Fig. e).

In more details, it will be shown *i*) quaternary epitaxial $Ba_{1-x}Sr_xTiO_3$ (BSTO), $Sr_{1-x}La_xTiO_3$ (SLTO), and $La_{1-x}Sr_xCrO_3$ (LSCO) solid solutions allowing the tunability of the physical properties (dielectric, thermoelectric,…) [3-4]; and *ii*) short-period [BTO/STO] or [LSTO/STO] superlattices down to ultimate [SrO/STO_n] superlattices known as STO Ruddleden-Popper (RP) phases, generating strong tunable structural anisotropy, of interest for phononic and optical properties [5-6], and *iii*) the epitaxy of various oxide layers on semiconductors, especially $SrTiO_3$ (STO) on Si(001) [7] and GaAs(001) [8] allowing the monolithic integration by epitaxy of various functional oxides on top [9].

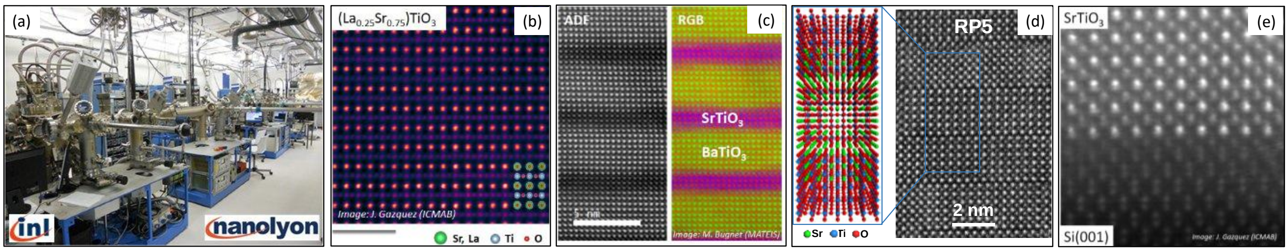

Figure: (a) MBE facilities in UHV line in the "pole epitaxy" cleanroom of the Nanolyon technological platform at INL; (b) $Sr_{0.75}La_{0.25}TiO_3/SrTiO_3(001)$ [3], (c) $[(BaTiO_3)_7/(SrTiO_3)_3]$ superlattice on $SrTiO_3$/Si(001), (d) $SrTiO_3$-based Ruddlesden-Popper phase (viewed as $[(SrO)_1/(SrTiO_3)_n]$ ultimate superlattice) on $SrTiO_3(001)$ [6], and (e) $SrTiO_3$/Si(001) [7], all epitaxially grown by oxide MBE at INL.

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