Origin of the 2DEG at oxide interfaces, relation with topology and with redox defects, and possible 1DEG

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When epitaxially depositing a thin film of lanthanum aluminate (LAO) on a strontium titanate (STO) substrate, both band-like insulators, a two-dimensional electron gas (2DEG) emerges at their interface displaying quite interesting and promising properties. The origin of such 2DEG is ascribed to the electrostatic energy build-up in the film due to an effective "chemical" or "compositional" charge at the interface, which destabilises the system towards the appearing of free carriers at the interface screening that charge.

In this talk we will first describe how such chemical charge comes about [1,2], in terms of a discontinuity in the polarisation of both bulk materials. Both STO and LAO are centrosymmetric and thus should be assigned zero effective polarisation, but in fact, while the former has zero polarisation, the latter has half a quantum of polarisation, the two possible distinct values for the formal polarisation of a centrosymmetric material in this context [1,2,3]. The two values correspond to two different values of the Berry phase for polarisation and therefore analogies can be drawn with the topological insulators arising relating to time inversion symmetry.

We will then argue how the electrostatic build-up would promote redox processes on or at the surface of the film [4], which compete with the proposed pure electron transfer (or "electronic reconstruction") as the source of carriers for the 2DEG. Finally, we will propose 1DEG formation possibilities in analogous stepped interfaces [5]. Such ideas will be reviewed and confronted with available experimental results and models based on first-principles calculations.

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