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# Epitaxially stabilized thin films of the potentially multiferroic materials ε-Fe2O3 and ε-AlxFe2-xO3.

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ε-Fe2O3 is a metastable intermediate phase of iron (III) oxide, between maghemite (γ-Fe2O3) and hematite (α-Fe2O3). Epsilon ferrite has been investigated essentially because of its ferrimagnetic ordering with a Curie temperature of circa 500 K. However, given its orthorhombic crystal structure that belongs to the non-centrosymmetric and polar space group *Pna21*, it should exhibit ferroelectric behavior along with magnetoelectric coupling of the two orders (potentially making it one of the few room temperature multiferroic materials).
Moreover, the material is characterized by strong magnetic anisotropy, resulting in a ferromagnetic resonance (FMR) frequency in the THz range in the absence of magnetic field and at room temperature. This is of particular interest given its potential use in short-range wireless communications (e.g. 60GHz WiFi) and ultrafast computer non-volatile memories.
Due to its metastable nature, ε-Fe2O3 needs to be stabilized at room temperature: to date such feature has been obtained mainly by synthesizing it by sol-gel as nanoparticles embedded inside a SiO2 matrix, with the stabilization mechanism being either pressure or size confinement (or both). Recently however, deposition of epitaxial thin films of ε-Fe2O3 on SrTiO3 (111) was demonstrated; in this case the stabilization is thought to be due to both epitaxial strain and interface interaction between the substrate and the film.

We report the growth by Pulsed Laser Deposition of epitaxial thin films of ε-Fe2O3 and
ε-AlxFe2-xO3 on different single crystal substrates, both oxides (SrTiO3, LaAlO3, LSAT, and YSZ) and non-oxides (single crystal Silicon), and discuss the influence of the chosen substrate and of aluminum doping on the structural, magnetic and dielectric properties. In particular, we focused our attention on the effect of Al inclusion inside the ε-Fe2O3 lattice, which should result (i) in the improvement of the electric properties, given the good ferroelectric properties of the isostructural AlFeO3, and (ii) in a lowering of the FMR frequency due to non-magnetic nature of Al.

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