Stabilization of the polar rhombohedal phase in $Hf_{0.5}Zr_{0.5}O_2$ layers

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Ferroelectric memories have been around for a few decades and their advantages in terms of low power consumption and switching speed are broadly recognized but, so far, their industrial presence was limited to low density niche applications due to issues with scalability. This has drastically changed recently with the discovery of ferroelectricity in nanoscaled hafnia-based films. A decade ago, HfO_2 as high-k gate oxide in MOSFETs gave rise to the 22 nm microchip technology, expedited by its ALD growth and facile CMOS integration. Short after, the unexpected discovery of ferroelectricity in ultra-thin layers of doped-HfO_2 upon crystallization [1,2] started puzzling the ferroelectrics community, which needed some time to recognize the many advantages of this new class of ferroelectrics and has brought HfO_2-based ferroelectrics into the spotlight. However, in order to further optimize these materials (i.e. reduction of coercive field, enhancement of polarization and cyclability) we need a better knowledge of the materials characteristics that distinguish hafnia-based ferroelectrics from the classical perovskites and other better studied ferroelectrics. Here, after a general introduction into this wonder material, I will present our quest in this direction by investigating the behavior of epitaxial rhombohedral single phase $Hf_{0.5}Zr_{0.5}O_2$ [3,4] and its evolution during device operation in tunnel junctions and memristors. I will present our later insights into the requirements for the stabilization of the rhombohedral phase [5], different from the generally reported polar orthorhombic phase [2].

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