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Characterization of nanostructured HfO2 films using Perturbed Angular Correlation (PAC) technique

After three decades mainly SiO2 was used as a gate dielectric in the silicon based CMOS (complementary-metalOxide-semiconductors) technology, and since integrated circuits are getting continuously smaller, the use of SiO2 is facing its technological limits. High-k materials substituting the SiO2 are currently under intense R&D to face the down-scaling process including the present CMOS technology. The basic idea is to find a material with a higher dielectric constant than that of SiO2, which is compatible with the present Si technology. Hafnium dioxide (HfO2) is an excellent candidate for gate dielectric in silicon transistors due to its high chemical stability, excellent dielectric properties (k ≈ 23) and mechanical hardness. Even though significant efforts have been dedicated to the investigation of Hf based gate dielectric material systems, key issues like bulk and interface oxygen diffusion, charge trapping, still lack a complete understanding when the target is a long-term operation of HfO2 based devices. Those studies are not focuses only in potential applications but are concerned also with fundamental physics problems. Crucial insight in the physics of these systems can be achieved only by atomic scale studies with direct measurements on the local structure and electronic environment. This work will report the investigation on HfO2 nano-films using Perturbed Angular Correlation (PAC) technique, where the presence of hafnium in the film assures the possibility of using 181Ta as probe. The HfO2 nano-films with different thicknesses were deposited on Si substrates using an electron beam evaporation process. The results will be discussed in terms of the physics underlying the local environment on the scale of a few atomic lengths monitoring microscopic regions.

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no

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