Influence of oxygen atmosphere in the annealing of HfO_2 thin films studied by perturbed angular correlation spectroscopy

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The thin films of HfO_2 have been grown by dual ion beam sputtering (DIBS) on transparent quartz substrates (grade silica) and silicon wafers. The major benefits of the DIBS process are the increased packing density of the deposited films which makes them more bulk-like, the improved adhesion resulting from the mixing of the materials at the interfaces between each layer, and the reduction of the high tensile stress in the layers. Deposition conditions were adjusted to obtain polycrystalline as well as amorphous films. In this study the time differential perturbed angular correlation (PAC) spectroscopy was used to study the influence of oxygen atmosphere in the annealing of the HfO_2 thin film. The PAC method is based on the hyperfine interaction of nuclear moments of the probe with extra nuclear magnetic fields or electric field gradients (EFGs). In the case of quadrupolar interaction, the experimental measurement gives the quadrupolar frequency ν_Q with respective distribution δ as well as the asymmetry parameter η of EFG. The presence of the ^{180}Hf isotope in natural hafnium allows the possibility of using ^{181}Ta as a probe nucleus formed by irradiating the samples with neutrons via $^{180}Hf(n,\gamma)^{181}Hf$ reaction. After irradiation, samples were annealed in oxygen atmosphere at different temperatures. The γ-γ PAC measurements were then carried out using a standard set up with four conical BaF_2 detector scintillators with a time resolution of 0.6 ns (FWHM). Results show a structural transition from monoclinic to tetragonal in the annealed samples.