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On the Mechanical Properties of the HfOx thin films deposited by Reactive DC Magnetron Sputtering

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HfO_2 thin films present many useful optical and electrical properties, such as high refractive index, high dielectric permittivity and high transmittance to visible light, among others. These properties make them useful in many fields, like as microelectronics, optical cells, solar energy conversion, mechanical applications, etc. Most of HfO_2 thin films are produced by chemical vapor deposition or reactive RF magnetron sputtering, however, the reactive DC magnetron sputtering technique allows a fine thickness control, homogeneity and stoichiometry of the deposited layer, this is a reliable technique for deposition a very thin films, which could be applied as insulator layer for dielectric gate in MOSFET devices. The deposition technique and conditions used alter significantly the film properties, for example, the dielectric constant value, which ranges from 18 to 25. Transition metal oxides presents unique mechanical properties which could vary according with the stoichiometry, crystal structure, inherent stress, etc, in the formed thin film. This is possible because two films could be obtained with equally stoichiometry but with different hardness due to the phase change. In this work HfO_2 thin films deposited by reactive DC magnetron sputtering and the Ar/O_2 ratio is dynamically controlled by a residual gas analyzer (RGA) during all the deposition process. The structural, compositional and crystallographic properties were carried out by glancing angle x-ray diffraction (GAXRD), Rutherford backscattering spectrometry (RBS) and wavelength x-ray fluorescence (WXRF). The hardness and elastic moduli of the samples were evaluated by indentation hardness test (IHT). The hardness results shown a significantly difference as the Ar/O_2 ratio is changed in the vacuum chamber, in fact, this atmosphere alteration shifts the crystalline structures from an amorphous through a monoclinic and finally a orthorhombic phase of the formed thin films.

Keywords
IHT
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