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XPS ANALYSIS OF THE INTERFACE LAYER IN NITRIDED HfO2/Si NANOFILMS

Hafnium-based materials have been crucial in electronic devices in the last few years. Current challenges are species migration and the growth of an interfacial layer (mainly after annealing), both hindering device performance. Nitridation is a possible solution. ARXPS provides non-destructive depth profiling information, offering valuable insights to understand the nitridation mechanism.
Using angle-resolved X-ray photoelectron spectroscopy, we characterized and explored the interface layer in HfO2/Si nanofilms before and after nitridation achieved through remote plasma. Hf 4f, Si 2p, O 1s, C 1s, and N 1s spectra were acquired at various plasma power levels (500 W-2500 W). We identified the peak components using advanced tools for spectral analysis, such as the Active Background and Simultaneous Fitting Approaches, both encompassed in the AAnalyzer®. By using the MultiLayer Method it was possible to assess the structure and composition, including undertainties, of the multilayered nanofilms.[1]
The growth of hafnia on silicon causes the formation of a high hafnium content silicate interfacial layer with a thickness of ~5 Å. Nitridation causes changes in composition in both the hafnium and silicate layers. HfO2 and HfO2-xNx coexist with the thickness remaining without significant changes. Hf1-wSiwO2 and Hf1-vSivO2-zNz coexist in augmented layer; this increment is due to residual oxygen in the plasma and exhibits a saturation behavior. The generation of a monolayer (~3 Å) of Si2+-N at the interface was observed; the electrical dipole of this structure causes a shift of ~0.2 eV to lower binding energies in the Hf 4f, O 1s, and C 1s spectra.

Keywords

XPS, Nitridation, interface, HfO2/Si

Reference

[1] A. Herrera-Gomez, D.M. Guzman-Bucio, M. Mayorga-Garay, O. Cortazar-Martinez, Angle resolved x-ray photoelectron spectroscopy assessment of the structure and composition of nanofilms—including uncertainties—through the multilayer model, Journal of Vacuum Science & Technology A 41 (2023).

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Author approval

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