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MICROSCOPY STUDIES OF HfO_2 ON GRAPHENE

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Ultrathin HfO_2 layers deposited by atomic layer deposition on unmodified graphene from $HfCl_4$ and H_2O were investigated with AFM and HR-SEM. Graphene flakes were prepared by the micromechanical cleaving method, which fixed them on oxidized silicon substrates. Hafnia ALD process was carried through in a hot wall gas phase reactor. The HfO_2 layers grown at low temperature were amorphous. Surface RMS roughness down to 0.5 nm was obtained for amorphous, 30 nm thick hafnia film grown at 180ºC. The HfO_2 layers grown at higher temperature of 300ºC had monoclinic structure, but the growth was nonuniform and the surface of these layers was rough, with RMS value of about 5 nm. HfO_2 was deposited also in a two-step temperature process where the initial growth of about 1 nm at 170 ºC was continued up to 15–40 nm at 300ºC. This process yielded uniform, monoclinic HfO_2 films with RMS roughness of 2.5 nm for 30 nm thick films. Raman spectroscopy studies revealed that the deposition process caused compressive biaxial strain in graphene whereas no extra defects were generated. Our studies also proved that using the low-temperature ALD method it is possible to modify the graphene's surface without preceding functionalization.

The possibilities of HR-SEM imaging of graphene and structures based on it will be discussed in presentation.