Reactive sputtering for highly oriented HfN film growth on Si(100) substrate

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Hafnium nitride have excellent properties such as high melting point, high hardness, low resistivity, which makes them potential in many technological fields. HfN have been investigated for diffusion barriers in semiconductor devices. $HfSi_2$ has been used for high temperature oxidation resistant coatings. However, there are no detailed studies for growth of epitaxial HfN/$HfSi_2$ films on Si substrate.

HfN films were grown on Si(100) substrates by reactive DC magnetron sputtering with Ar/N_2 gas mixture using a Hf target. The deposition was carried out by varying N_2 flow ratio and the power at 5 mTorr and 850°C.

XRD results with cross-sectional TEM/STEM show that low N_2 flow ratio favors the formation of the $HfSi_2$ interlayer between HfN and Si, while no $HfSi_2$ diffraction peaks can be seen for high N_2 flow ratio of 12.5% (Fig. 1). Also, increasing the applied power for sputtering results in the increase of the HfN peak intensity ratio of (200)/(111). Furthermore, it is shown that the orthorhombic $HfSi_2$ interlayer is in epitaxy with Si (100) and those (100) oriented HfN grains are found in epitaxy with both $HfSi_2$ and Si as well. The epitaxial relationship is HfN (100) [011] // $HfSi_2$ (020) [100] // Si (100) [011].

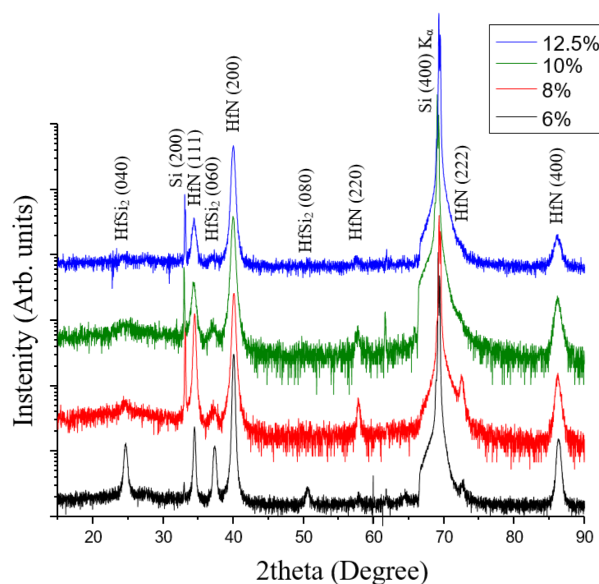

Fig. 1 XRD of HfN films grown on Si with different N_2 ratio.

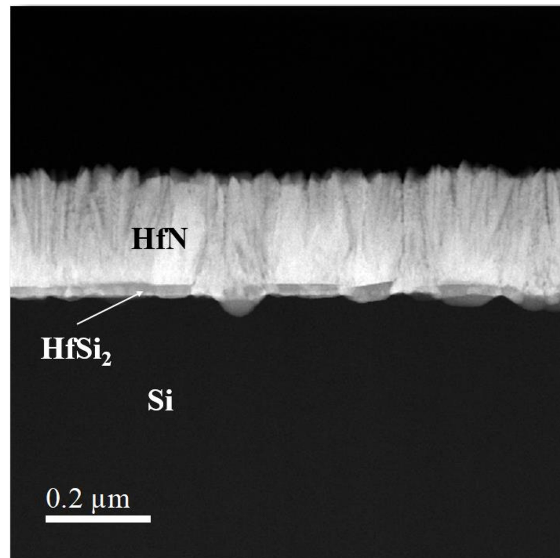

Fig. 2 STEM-ADF image of HfN/Si in cross-section view. $HfSi_2$ is present between HfN and Si interface.

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