High resolution patterning of Hafnium oxide based resist by EUV and Electron beam lithography

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The progress in downscaling of complementary metal oxide semiconductor transistors leads to a very thin layer of silicon dioxide that its leakage current is becoming a major challenge. It is necessary to replace the SiO_2 with a physically thicker layer of oxides of higher dielectric constant (κ) gate oxides such as hafnium oxide and hafnium silicate. Little was known about such oxides, and intensive research is underway to develop these oxides into new high quality electronic materials.[1]

Hafnium oxide resist from Inpria corp. is based on a fundamentally new approach that relies on the deposition of extremely high quality amorphous metal oxide films from aqueous solution and efficient photon-induced network forming reaction. Tests on Inpria's resist have given high density and smoothness on the order of 0.2 nm RMS. [2]

The resolution capabilities of HfO_2 based resist from Inpria corp. have been tested by electron beam and EUV lithography. We could demonstrate the high-resolution capabilities of this negative tone resist. Half-pitch of 11 nm is shown by electron beam as well as by EUV lithography.

The high EUV absorption of this resist ($16\mu m^{-1}$) is a good advantage for EUVL and enables the use of thin films and high fraction of EUV photons. It is also more sensitive to the e-beam exposure than other high-resolution inorganic resists such as hydrogen silsesquioxane (HSQ). Therefore, it a very promising resist for high-resolution patterning with EUV and e-beam lithography, thanks to with its sensitivity and resolution.

We also show in this paper that this resist can be used to improve the EUVL mask fabrication for high-resolution patterning down to sub-10 nm patterns. Its superior performance in terms of aspect-ratio, and high etch selectivity as well as being a spin-coateble oxide with high refractive index, offers great potential for various applications.

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[1] J. Robertson Eur. Phys. J. Appl. Phys. **28**, 265–291 (2004)

[2] J. Stowers et al. Proc. Of SPIE Vol. 7969 796915-2

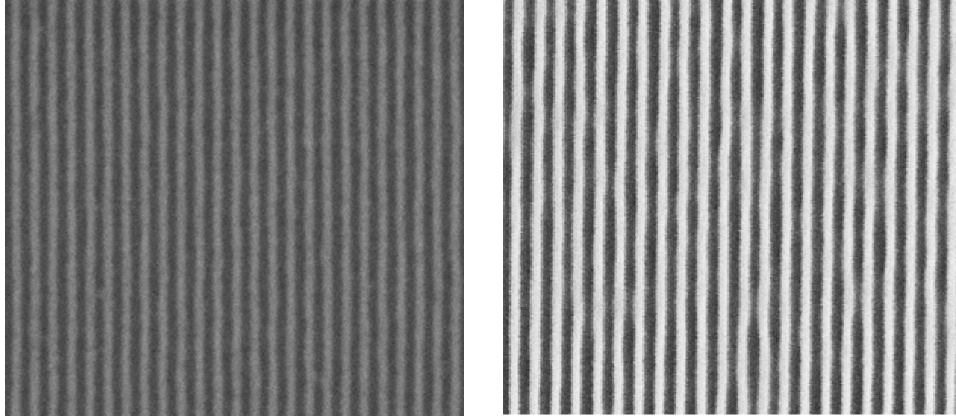

Figure 1 SEM images of 11 nm Half-Pitch of HfO_2 lines obtained by Electron Beam lithography (left) and by EUV interference lithography at Paul Scherrer Institute (right)