

NOVELLUS INTRODUCES CERAMIC HARD MASK MATERIALS FOR USE IN SUB-22NM BACK-END-OF-LINE PATTERNING

San Jose, California - November 9, 2011 - Novellus Systems (NASDAQ: NVLS) announced today that the company has developed new ceramic hard mask (CHM) materials for use in sub-22nm patterning applications. Deposited using Novellus' industry-leading VECTOR[®] plasma-enhanced chemical vapor deposition (PECVD) platform, the new materials allow for the controlled incorporation of dopants into the company's family of silicon carbide and silicon nitride films.

Hard mask films are often used as an aid in critical patterning applications for back-end-of-line (BEOL) inter-level dielectric (ILD) materials. These hard mask films should have a high etch selectivity with respect to the ILD material, be compatible with basic lithography processes and be capable of removal without damaging the underlying ILD layer. Titanium nitride (TiN), which has a high etch selectivity with respect to ILD, is typically used as a metallic hard mask. However, as device dimensions shrink below the sub-22nm technology node, there is a series of integration challenges associated with using this film. These range from high compressive stress, which causes the mechanically weak, ultra-low k (ULK) ILD to deform (resulting in pattern distortion) to compatibility issues with the polymer formed to protect the ULK sidewall during the etch process.

In contrast, Novellus' CHM materials present several unique advantages compared to TiN hard masks. Although very hard, the CHM film can be removed by CMP due to the chemical interaction of the material with the CMP slurry - this, in turn, reduces the cost of ownership in comparison to metallic hard masks. Figure 1 shows that film families A, B and D demonstrate acceptable CMP removal rates. The CHM film is also tensile, eliminating the line bending concerns while also affording excellent etch selectivity to ULK. These films can also be etched in the dielectric etchers that are already available in the fab's production flow. In contrast, TiN hard masks require the addition of metal etchers in the production line.

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In addition to the productivity advantages afforded by these new ceramic hard masks, the films demonstrate excellent technical performance. Figure 1 shows that film families C and D offer high etch selectivity, removing the ceramic hard mask without damaging the porous ULK ILD materials. Figure 2 shows that film families B and D are also highly tensile, resolving the line bending issues associated with highly compressive TiN films. Materials in film family D possess a tensile stress that is compatible with weak ULK under-layers, and materials in film family B possess low compressive to neutral stresses.

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The innovative CHM technology developed by Novellus engineers demonstrates that TiN metal hard masks can be replaced by ceramic hard masks, bringing a number of manufacturing process improvements. Etch byproducts from ceramic hard materials are volatile, and are therefore easier to integrate - there are no additional steps required to manage the etch by-products, unlike in the etch of metal hard masks where non-volatile etch byproducts require additional steps. Manufacturability is also improved, since the ceramic hard mask materials do not require the strict queue time controls that are needed with metal hard mask materials in order to manage the etch by-products. Ceramic hard mask materials also offer the lowest cost of ownership to customers, since device manufacturers do not need the additional production steps outlined above, nor additional toolsets (metal etchers). In sum, these ceramic hard mask materials with their tunable stress (low tensile), low etch rates and high modulus are the most versatile replacement candidates for metallic hard masks.

"The introduction of porous ULK materials in sub-28nm technologies brings new challenges that present opportunities for novel materials," said Sesha Varadarajan, senior vice president of Novellus' PECVD Business Unit. "Ceramic hard mask materials deposited on the VECTOR platform represent a replacement candidate for the TiN hard mask. Not only are we resolving integration issues inherent with metal hard masks, we are doing so using a fundamentally cheaper PECVD deposition technique, which continues Novellus' long-standing tradition of offering highly productive enabling technologies to our global customers."

For more information about Novellus' ceramic hard mask films, please visit www.novellustechnews.com.

About Novellus' PECVD Technology:

The multi-station sequential processing (MSSP) architecture of Novellus' VECTOR platform allows for independent temperature and flow control to its deposition stations, critical in meeting the integration needs of sub-3xnm technology nodes. More than 1,000 VECTOR systems have been installed in logic, memory and foundry fabs around the world.

About Novellus:

Novellus Systems, Inc. (Nasdaq: NVLS) is a leading provider of advanced process equipment for the global semiconductor industry. The company's products deliver value to customers by providing innovative technology backed by trusted productivity. An S&P 500 company, Novellus is headquartered in San Jose, Calif. with subsidiary offices across the globe. For more information, please visit www.novellus.com.

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