

NOVELLUS' NEW TUNGSTEN NITRIDE (WN) PROCESS ENABLES ADVANCED COPPER INTERCONNECTS FOR 3Xnm MEMORY DEVICES AND BEYOND

San Jose, California - May 6, 2010 - Novellus Systems (NASDAQ: NVLS) announced today that it has developed an innovative DirectFill CVD tungsten nitride (WN) liner-barrier film that replaces the conventional physical vapor deposition (PVD) Ti liner and metallo-organic chemical vapor deposition (MOCVD) TiN barrier film stack used for the tungsten via to copper interconnect application in advanced memory devices. The WN film is deposited using Novellus' ALTUS platform with multi-station sequential deposition (MSSD) architecture and patented pulsed nucleation layer (PNL[®]) technology. The DirectFill process deposits an ultra-thin, 20 angstrom WN film with better barrier and resistivity properties compared to the conventional 200 angstrom thick PVD Ti - MOCVD TiN film stack. This ultra-thin film reduces the tungsten via resistance by up to 30 percent, and extends the tungsten via process to the 3Xnm technology node and beyond.

Increasing demand for faster and more energy-efficient memory devices and shrinking feature dimensions have created a need to integrate copper interconnects into Flash and DRAM devices. A commonly-used integration scheme incorporates a copper interconnect for the first metal layer and uses more traditional aluminum interconnects for the subsequent layers. This integration scheme requires the use of a tungsten via to make the electrical connection from the first copper layer to the aluminum layers. The shrinking dimensions of the 3Xnm technology node are creating new integration and scalability challenges for the traditional Ti/TiN liner-barrier stack used in the tungsten via process sequence. Overhang of the PVD-Ti liner reduces the opening of the via, which in turn can lead to incomplete CVD tungsten fill, creating a void in the center of the via. MOCVD TiN films must be deposited with a minimum thickness to prevent silane - a gas used during the tungsten plug fill process - from diffusing through the barrier and forming a high-resistivity copper silicide at the via interface. A breakdown in the TiN barrier can also result in tungsten hexafluoride attack of the Ti liner, resulting in volcano defects. These PVD Ti and MOCVD TiN integration issues can result in higher via resistance, degraded electrical performance, and poor device reliability.

Novellus engineers have overcome these challenges by developing a single step DirectFill PNL WN liner-barrier film that replaces the conventional multi-step PVD Ti - MOCVD TiN film stack. The PNL WN process technology deposits a highly conformal, 20 angstrom thick barrier layer with a micro-crystalline structure that makes it an excellent low resistivity diffusion barrier. The conformal nature of the deposition eliminates the step coverage and subsequent fill issues associated with conventional liner-barrier technology, and the film structure eliminates the diffusion barrier breakdown mechanisms that result in copper silicide formation and volcano defects. Figure 1 shows a TEM image of a tungsten via in contact with a copper interconnect, where a WN film was used as the barrier layer. The TEM shows that the highly conformal WN film results in void-free tungsten fill and a clean interface between the Cu and W/WN via plug. In addition, the ultra-thin, highly conformal WN layer results in up to 30 percent lower via resistance versus the traditional PVD Ti - MOCVD TiN liner-barrier stack and the patented MSSD processing provides the industry's best productivity for films in this class.

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"DirectFill WN technology provides our customers with an advanced tungsten barrier film for memory applications that eliminates the integration issues associated with conventional PVD Ti - MOCVD TiN liner-barrier films," said Aaron Fellis, associate vice president and general manager of the Direct Metals business unit. "The superior step coverage and integration performance of this new WN film enables our customers to extend the performance of their copper interconnects to the 3Xnm technology node and beyond."

About Novellus's ALTUS Tungsten Deposition Technology:

Introduced in 1991, ALTUS is the industry's tool of choice for tungsten contact and local interconnect applications. The ALTUS PNL technology integrates a high-throughput, advanced nucleation layer with a bulk chemical vapor deposition fill process. Novellus' Multi-Station Sequential Deposition (MSSD) architecture enables the nucleation layer and CVD fill to be performed sequentially on separate stations within the same ALTUS chamber. The integrated PNL and CVD approach produces benchmark productivity and production availability, resulting in the lowest-cost-of-ownership tungsten deposition solution in the industry.

About Novellus:

Novellus Systems, Inc. (NASDAQ: NVLS) is a leading provider of advanced process equipment for the global semiconductor industry. An S&P 500 company, Novellus is headquartered in San Jose, Calif. with subsidiary offices across the globe. For more information, please visit www.novellustechnews.com

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