TECH HIGHLIGHTS

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A New, Fast, Reliable Method for Doping Measurements in Thin SOI Films

There has been dramatic progress in silicon-on-insulator (SOI) materials over the past decade. Today, commercially-available, high-quality SOI materials are finding applications in the fabrication of radiation-hardened integrated circuits. In addition, SOI offers considerable potential for microelectronic products with higher densities, smaller chip sizes, higher device speeds, lower power requirements, and improved device performance. To achieve the full promise of SOI technology, characterization methods and an understanding of the relationships between materials properties and those of devices built on the SOI device layer are essential. Researchers at LETI-CEA, SOITEC, and J. Fourier University, all in France, have reported a new method for characterizing the background doping in thin SOI films. The technique, which they term the three-Schottky diode method, employs three metal/silicon contacts on the front side of the wafer. Mercury contacts work very well and were demonstrated to produce no damage to the wafer in the contact region. The Schottky diode characteristics were shown to be strongly dependent on dopant type and concentration, allowing unambiguous determinations. Further, in contrast to other methods used to determine doping type, this technique excels for high resistivity samples.

*From: J. Electrochem. Soc., **146**(7), 2737 (1999).*

Effects of Additives for Copper Electrodeposition

Leveling and brightening effects of plating bath additives have been known for some time, but much of the understanding of the function of these proprietary additives is empirical. This knowledge base has been successfully applied to printed circuit board (PCB) plating, but it is unclear whether the same additive systems will be appropriate for on-chip copper interconnects, which have a much smaller characteristic length scale (1 micron or smaller vs. 100 microns). Kelly, Tian, and West, at Columbia University, have studied the mechanistic role of two model additives taken from the patent literature for acid-copper sulfate PCB plating. In addition to the two additives, bis(3-sulfopropyl) disulfide (SPS) and Janus Green B, the bath also contained polyethylene glycol and chloride ion. The researchers used SEM and TEM to characterize the microstructure and thickness profile of the deposits. The plating was done under controlled hydrodynamic conditions using a rotating cylinder electrode, and the cylinder was threaded to study leveling effects. The study showed that leveling occurs only when all four additives are present, suggesting that additive-additive interactions are important to the leveling mechanism. The existence of an optimal flux of the active leveling agent suggests that the diffusion-adsorption theory used to explain simple single-additive systems may also apply to more complex additive systems.

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Electrochemical Micromachining of Titanium

Electrochemical micromachining (EMM) of chemically resistant metals such as titanium can offer higher machining rates and better control than chemical etching. Increasing interest in micromachining of titanium for use in such industries as aerospace and biomedical (e.g., for implants with improved biocompatibility) led researchers at the Ecole Polytechnique Federale de Lausanne in Switzerland to investigate EMM of titanium from an experimental and theoretical point of view. They used a solution of sulfuric acid in methanol for electrochemical etching. Using a boundary element method, numerical simulation of the EMM was also performed. Madore, Piotrowski, and Landolt showed that the calculated and experimentally determined shape changes of titanium during EMM could be described using the rate-limiting step of diffusion of reaction products in the concentration field. Under well-controlled, diffusion-limited conditions, parallel channels and other regular structures could be accurately machined into the titanium. To attain such well-controlled conditions, perturbations to the formation and removal of the anodic film and Joule heating of the electrolyte had to be minimized.

*From: J. Electrochem. Soc., **146**(7), 2526 (1999).*

A Novel Lithium-Inserting Electroactive Polymer

Transition metal oxides are the materials of choice for the positive electrode in lithium-ion rechargeable batteries. Haringer, Novak, Haas, Piro, and Pham at the Paul Scherrer Institute in Switzerland and at the Institut de Topologie et de Dynamique des Systèmes de Université in Paris have reported their research aimed at development of polymer based cathode materials. The conducting polymer studied by this group is poly(5-amino-1, 4-naphthoquinone), and it exhibits two well defined electron transfer processes in nonaqueous systems. In a battery configuration the polymer is said to exhibit a nominal charge/discharge voltage of 2.6 V (vs Li/Li^+) and an initial reversible capacity of up to 290 Ah/kg, which is close to its theoretical capacity. Another interesting feature of this material noted by the authors is the intrinsic overcharge protection characteristics of this material, although evaluations of this material characteristic was not reported here.

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Characterization of Amorphous Fluorocarbons for Low k Interlayer Dielectrics

The rapid pace of development in integrated circuit technology has spurred the search for and development of new materials for special applications. In the area of interlayer dielectrics (ILDs), there is a need for materials with low dielectric constants (k). Such materials, in combination with copper conductors, will allow faster device performance via reduction in gate and interconnect delays. In addition, line-to-line capacitances should be minimized as well. Among materials being considered for low k interlayer dielectric applications are xerogels, siloxane polymers, hydrocarbon polymers, and fluoropolymers. One of the key requirements for integration of these materials into integrated circuits is an ability to withstand several subsequent high temperature process steps required for deposition of additional metal and dielectric layers. Researchers at Intel Corporation, Portland Technology Development, and MIT have reported the results of fourier transform infrared (FTIR) spectroscopy, x-ray photoelectron spectroscopy (XPS), nuclear magnetic resonance (NMR) spectroscopy, thermal gravimetric analysis (TGA), and thermal desorption/mass spectroscopy (TD/MS) studies of a fluorinated amorphous carbon material deposited by CVD. The material is largely a saturated C-F polymer, but contains some unsaturated C=O and C=C groups as well. The authors report that fluorine and hydrogen fluoride are among the byproducts of thermal processing of this material, both of which can be detrimental to other materials in the circuit. They conclude that even though the material shows promise as a low k dielectric ($k = 2.4$), additional improvements are needed to improve its thermal stability before this material, as well as similar fluorocarbons, finds use in the semiconductor industry.

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