TECH HIGHLIGHTS

A New Rate Equation for Chemical Mechanical Polishing Processes

Chemical mechanical polishing (CMP) has, in the last several years, found applications in integrated circuit fabrication for planarization of interlevel dielectrics and metal interconnects. In CMP, a silicon wafer is pressed onto a rotating pad with polishing slurry flowing between the wafer and the pad. An empirical relation (the Preston equation) has often been used to relate the CMP removal rate to the product of the polish pressure and the linear speed at the wafer-pad surface. Researchers at Conexant Systems and the University of California at Irvine recently proposed a new polishing rate equation that considers the tribological interactions among abrasive particles, the polished wafer surface, and the polishing pad itself. B. Zhao and F. Shi showed that the polishing rate could be described by a premultiplying factor (related to the polishing velocity and other CMP parameters) times the difference between the polishing pressure and a threshold polishing pressure, each raised to the 2/3rds power. Agreement between experiment and this polishing rate equation was excellent for oxide CMP as well as for tungsten, aluminum, and copper CMP.

From: Electrochem. Solid-State Lett., ***2****, 145 (1999).*

Micropatterned Metal Oxide Films via Microtransfer Molding and Electrodeposition

Redox-active metal-oxide materials are interesting for a wide variety of applications such as electrochromics, photocatalysis, photovoltaics, and batteries. The ability to control the deposition and patterning of these materials is critical to the development of useful devices. Recently, the use of soft lithography, such as microcontact printing, has received significant attention due to its low cost compared to conventional lithography. A variation of microcontact printing is called microtransfer molding, in which a pattern is embossed or molded into a compliant material. Researchers at Northwestern University have applied microtransfer molding with electrochemical deposition to create micron-scale patterns of metal oxide thin films on transparent, conductive indium tin oxide. The authors created a polydimethylsiloxane stamp and used it to mold a transparent, thermally-curable epoxy. The cured epoxy pattern was then used as a template for electrodepositing metal oxide films from an aqueous metal-hydrogen peroxide solution. The authors suggest that this method offers distinct advantages, such as lower cost, thicker films with precise electrochemical control, and fewer processing steps than existing techniques. They also point out that the technique can be applied to other materials, such as organic and metallopolymeric films.

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Atomic Layers of Selenium and Tellurium on Gold

The surface chemical reactions of some Group VIB elements have been extensively studied due to their importance in a variety of industries. Oxidation and sulfidation of semiconductor surfaces are important in the manufacture and performance of electronic and optoelectronic devices. Further, oxidation and sulfidation of metals are important to the performance and durability of mechanical and electronic parts fabricated from these materials. The surface chemistry of selenium and tellurium, in contrast, has received far less attention. Researchers at the University of Georgia have reported the results of scanning tunneling microscopy studies of the electrodeposition of these chalcogens on single-crystal gold surfaces. A low coverage structure consisting of an epitaxial layer of atoms is formed by an underpotential deposition mechanism (for tellurium) and an overpotential deposition mechanism (for selenium) at low potentials. At higher potentials, structures composed of chains or rings of the atoms are formed. These structures are hypothesized to have significant molecular character, in terms of the overlap of electronic orbitals of adjacent atoms, and the authors present mechanisms to account for their formation.

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Wafer Bonding: Quartz-to-Quartz

The rapid pace of development of microelectromechanical systems has resulted from the convergence of advanced fabrication techniques (e.g., from the semiconductor industry) with novel, often revolutionary, approaches for miniaturizing device designs. A number of substrate materials have found important applications in this emerging area, including quartz, silicon, compound semiconductors, and glass. Quartz is particularly useful because it is UV transparent, chemically inert, insulating, piezoelectric, and because it forms a useful double layer in the presence of acidic and basic electrolytes. Researchers at Uppsala University in Sweden and BCO Technologies in the United Kingdom have developed a simple, straightforward method for the direct bonding of two quartz wafers. The method does not require an intermediate adhesion layer nor annealing temperatures above the phase transition temperature of quartz (573°C). Rather, it is accomplished simply by making the quartz surfaces hydrophilic (by immersion in boiling nitric acid) followed by direct contact of the hydrophilic surfaces in air. Bonding occurs spontaneously at room temperature, and anneals in nitrogen at temperatures below 400°C were shown to dramatically improve the wafer bond strength. This type of direct bonding has not, to the authors's knowledge, been previously reported, and could open new fabrication avenues for quartz sensors, resonators, actuators, and integrated chemical analysis systems.

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Thin, Smooth, and Uniform Platinum Silicides

PtSi is one of the most common silicides in infrared Schottky barrier detectors due to its low Schottky barrier height to p-type silicon. The performance of these detectors is critically dependent on the uniformity and thickness of this silicide layer, which is typically formed by the evaporation of Pt onto heated substrates followed by a high-temperature anneal (to form the silicide) and a selective wet etch (to remove unreacted Pt from the oxide which forms over the silicide). Researchers at IMEC and the Katholieke Universiteit in Belgium have devised a new process for the formation of ultrathin layers of PtSi. Platinum is sputter-deposited onto an unheated silicon, and the deposited Pt is then removed by selective etching in an aqueous mixture of nitric and hydrochloric acids. During this etch step, the authors propose that the Pt is removed at a rapid rate until the interfacial layer is reached. Here, the silicon present in the now exposed Pt-Si layer is oxidized to form an etch stop layer. Also during this etch step, the authors hypothesize that the intermixed Pt-Si layer is transformed into a PtSi silicide via a short-range diffusion mechanism. A subsequent rapid thermal anneal is used to improve the uniformity of the grain size distribution.

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