A Holistic Approach to Optimizing Chemical Mechanical Planarization (CMP) for Enhanced Semiconductor Manufacturing and Sustainability

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As semiconductor technologies such as autonomous driving, artificial intelligence, 5G communications, the Internet of Things, and large-scale data processing grow, the need for a dependable semiconductor industry escalates. This surge necessitates the utilization of sophisticated device architectures, which significantly depend on Chemical Mechanical Planarization (CMP) and post-CMP cleaning processes. This seminar highlights the development of CMP slurries and post-CMP cleaning solutions, focusing on their essential role in these processes. Our study delves into the comprehensive development of CMP slurries and post-CMP cleaning solutions. We underscore how synthesis methods drastically influence the surface chemistry of ceria abrasives, impacting the removal rates of the SiO2 surface during shallow trench isolation (STI) CMP. We demonstrate how our cleaning solutions facilitate the near-complete removal of even the most stubborn 10 nm-sized ceria particles from SiO2 surfaces, thereby enhancing the efficiency of the process.

Additionally, we highlight how the utilization of aliphatic amino acids as environmentally friendly corrosion inhibitors in CMP slurries offers an effective alternative to the traditionally used benzotriazole (BTA), addressing key environmental challenges presented by the latter. Our research provides insights into the distinct functionalities of these amino acids, establishing Methionine as the most effective inhibitor against galvanic corrosion. In light of the rapidly expanding semiconductor industry, addressing global sustainability concerns and environmental health and safety (EHS) objectives becomes critical. Our research proposes a comprehensive methodology for evaluating the sustainability of CMP consumables in semiconductor manufacturing, concentrating initially on CMP slurries due to their significant market share and shorter usage lifetimes. This research lays the foundation for future CMP sustainability analyses, promoting self-correction strategies within the CMP community to reduce environmental impact. A robust framework for the Life Cycle Assessment (LCA) of CMP consumables is introduced, marking a crucial step toward achieving these goals.

In summary, this seminar explores the intricate details of CMP and post-CMP processes, their role in the advancement of semiconductor manufacturing, and the important task of aligning these processes with environmental and sustainability goals.