Electrochemical Interactions in Metal Planarization Technologies

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CMP involves complex interplay between chemical and mechanical components. Compared oxide CMP has been in practice for about a decade, metal CMP (particularly copper CMP) is relatively less understood technology. Factors such as abrasive loading, pH, down-force, table speed can be used successfully to model removal rates in oxide CMP. However, the metal CMP slurries are highly complex, employing variety of additives such as inhibitors, complexing agents and surfactants. These additives strongly influence electrochemical behavior of copper during CMP. These complex interactions often result in non-Prestonian removal behavior, which is more difficult to predict and model. Even more difficult is understanding the impact of electrochemical processes on planarization and dishing/erosion. Conventional models based on step height reduction/increase are inadequate to model the planarity aspects of metal CMP. Pad conditioning also significantly influences the electrochemical processes through alterations in CMP byproduct concentrations, pad roughness and frictional interactions.

In this paper, we demonstrate and discuss specific examples of these interactions and provide some perspectives into understanding complex chemical-mechanical interactions involved in CMP. These interactions are also contrasted with those involved in electropolishing technology, which is gaining attention as a planarization technology for metal interconnection schemes using porous ultra-lowK materials.