

## Adhesion and removal of particles in semiconductor process

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The adhesion force of silica particles to Cu films and the role of additives on adhesion and removal of particles have been theoretically and experimentally investigated in citric acid based post Cu CMP cleaning solutions. The zeta potential of silica and Cu slightly increases when citric acid is added due to the adsorption of citrates. Citric acid is adsorbed on silica and Cu surfaces, resulting in more negative charges on these surfaces. The adhesion force of silica particles on Cu decreases as the citric acid concentration increases due to more repulsive electrostatic interaction between surfaces. The addition of BTA in the cleaning solution initially decreases adhesion then increases it at high concentrations due to the change in zeta potentials. The addition of TMAH to citric acid increases the particle adhesion force. However, the addition of  $\text{NH}_4\text{OH}$  results in the lowest adhesion forces. The highest particle removal efficiency is observed when using cleaning solutions that yields the lowest adhesion force.