AFM induced sensitization of semiconductor surface for electrodeposition

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Selective deposition of metallic films on semiconductor surfaces has attracted increased interest recently, due to possible applications in microelectronics, especially in the formation of micro- and nano-structures on semiconductors.

Several approaches have been explored over the past few years mainly based on direct writing with particle beams [1], self-organization [2] or surface modification using scanning probe techniques (AFM/STM) [3]. One particular approach uses scanning probe microscopies to directly modify a resist film by scratching. Atomic Force Microscope (AFM)-scratching through masking layers is discussed within this work. The masking layer can be a resist layer such as polymethylmethacrylate [4,5], a self-assembled monolayer (SAM) [3], or an oxide film [6,7].

This work extends our previous studies. The masking layers can be either different SAMs or thin oxide layers. The deposition is carried out either by cathodic potential step deposition or by immersion plating. The deposition parameters were also studied in detail to investigate the nucleation and growing morphology. The nucleation and growing morphology of copper at high voltage pulse on both oxide covered and non-oxide covered silicon surfaces was also studied. We demonstrate that thin oxide layers can act as a very efficient resist even at comparably high voltages. Fig. 1. Even more remarkably, using high voltage pulse (-100V vs Ag/AgCl) on oxide free n-type silicon surface, copper nuclei can be preferentially deposited on the scratches as we can see from Fig.2. This cannot be ascribed to selective Schottky barrier breakdown at the surface defects introduced by scratching, as several times proposed for p-type material.

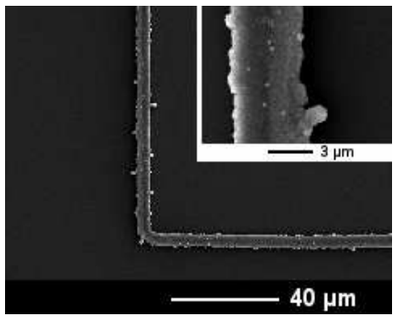

Fig. 1: SEM image of copper deposited on 10 nm oxide covered n-Si (100). The scratch was performed by a micro-indenter (F=49.03 mN) through the oxide layer. The Cu deposition was carried out by a cathodic potential step at –100 V (vs Ag/AgCl) in $CuSO_4$ (0.1 M) + H_2SO_4 (0.5 M) electrolyte for 10ms.

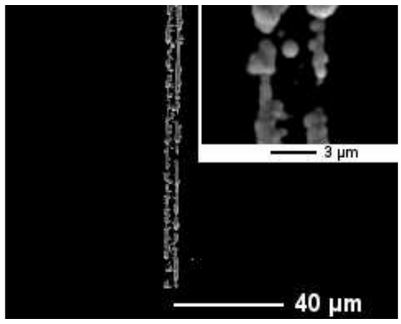

Fig.2: SEM image of copper deposited on Si (100) n-Si. The scratch was performed by a micro-indenter (F=49.03 mN) through the native oxide. The Cu deposition was carried out by a cathodic potential step at –100 V (vs Ag/AgCl) in $CuSO_4$ (0.1 M) + H_2SO_4 (0.5 M) electrolyte for 1ms after dip into 1% HF for 1 min.

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