MODELING AND SIMULATION OF THIN AL-FILMS UNDER CYCLIC THERMAL LOADING

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ABSTRACT

Growing demands on performance and durability of integrated circuits (ICs) require an understanding of possible failure mechanisms. One main cause for damage of ICs arises from thermo-mechanical loads of the involved materials as a result of current pulses. The mismatch in thermal expansion leads to stresses which cause crack initiation and, in consequence, short circuits and the loss of functionality of the assembly.

This study presents a series of numerical simulations using a three dimensional model considering aluminium films sputtered on a silicon substrate and surrounded by a passivation layer. The thermo-mechanical problem is solved utilizing the *Abaqus/Standard* solver in combination with an user-defined material subroutine which takes into account the microstructure, the grain orientation and the temperature dependent anisotropic visco-plastic material behaviour of aluminium. Voronoi tessellation is used to model a realistic microstructure. The passivation layer and the silicon substrate are supposed to behave elastically and temperature dependent.

We investigate the influence of the microstructure on the stress and strain distribution within the model by changing the grains' orientation, size and distribution. Where possible, the simulation results are compared with experimental results taken from literature. Observations like surface roughening, crack initiation and life extension when decreasing the aluminium film thickness can be predicted qualitatively correct.