NUMERICAL STUDY OF ELECTROMIGRATION IN PASSIVATED INTERCONNECTS

By

Youzhang Ge

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Examining Committee:

Antoinette M. Maniatty, Thesis Adviser
T. Paul Chow, Member
Catalin R. Picu, Member
Lucy T. Zhang, Member

Rensselaer Polytechnic Institute
Troy, New York

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ABSTRACT

This study aims at providing a more accurate numerical simulation of electromigration (EM) in a passivated interconnect line. An EM model is developed, based on the work by Sarychev et al. [4], to include the effect of diffusion path into the analysis. In this model, EM is considered as the diffusion of vacancies assisted by three driving forces, which are the force due to the electric field, the force due to mechanical stress gradient and the force due to the concentration gradient. The vacancy concentration field and the mechanical stress field are coupled through the hydrostatic stresses and the EM-induced inelastic strains. The EM model is implemented and solved in 3D using Finite Element Method (FEM). In our simulations, the passivation layer is treated first as infinitely rigid, which is an approximation, and then compliant, which is the real condition. By comparing experimental measurements with numerical calculations, the primary diffusion path in a sample Al line is identified to be along the top and bottom interfaces. Local strain measurements and numerical simulation indicate that EM flux is nonuniform across the width of the conductor line, with more EM flux near the center than near the edges of the line. The passivation layer plays an important role in determining the strain/stress state. For the same amount of EM time, the hydrostatic stress prediction is much higher in the case with infinitely rigid passivation layer than where passivation layer is explicitly modeled.