2013 IEEE International Interconnect Technology Conference
June 13-15, 2013 Kyoto Research Park, Kyoto, Japan

TECHNICAL SESSIONS

June 13, 2013

13:40-15:25

Session 3: Reliability
Session Co-chairs:
Larry Zhao, GLOBALFOUNDRIES
Shinichi Ogawa, AIST

13:40-14:10

3-1 ***INVITED - The Electromigration Short " Length Effect and Its Impact on Circuit Reliability***

Anthony Oates
TSMC, Taiwan

<Abstract>
The short-length effect, whereby electromigration is eliminated due a mechanical stress gradient induced backflow, has long been recognized as a fundamental facet of electromigration failure of IC interconnects. More recently, the short " length effect has been shown to have a profound impact on the statistics of electromigration failure. In this presentation we will review recent experimental studies of short-length effects in Cu/low-k interconnects, and the statistical modeling of failure distributions. The most significant finding is that failure can occur at average current densities below the critical value implied by the critical current density " length product. This results from manufacturing variability in conductor geometry and in the critical current density itself. On this basis we can accurately model failure distributions as a function of stress variables, conductor geometry, and presence of reservoirs. We also propose a new reliability extrapolation procedure to account for short-length effects.

14:10-14:35

3-2 ***Critical Initial Void Growth for Electromigration: Stress Modeling and Multi-Link Statistics for Cu/Low-K Interconnects***

Zhuojie Wu{2}, Linjun Cao{2}, Jay Im{2}, Ki-Don Lee{1}, Paul Ho{2}
{1}Texas Instruments, United States; {2}The University of Texas at Austin, United States

<Abstract>
This paper investigated the initial void growth that determines the electromigration failure time for Cu/low-k interconnects. A method to derive the initial void growth rate prior to line failure by analyzing the resistance traces was developed. The statistical data from multi-linked structures show a linear relationship between the void growth rates before and after failure. An extended the Korhonen model was developed taking into account the stress effect on void growth for Cu interconnects. The model was able to account for the observed EM statistics, thus suggesting that the effect of stress should be included for EM lifetime extrapolation.

14:35-15:00

3-3 ***Void Nucleation and Growth During Electromigration in 30 nm Wide Cu Lines: Impact of Different Interfaces on Failure Mode***

Tomoyuki Kirimura{1}, Kristof Croes{2}, Yong Kong Siew{2}, Kris Vanstreels{2}, Piotr Czarnecki{2}, Zaid El-Mekki{2}, Marleen van der Veen{2}, Dries Dictus{3}, Alex Yoon{3}, Artur Kolics{3}, Juergen Boemmels{2}, Zsolt Tokei{2}
{1}Fujitsu Semiconductor Europe, Belgium; {2}Imec, Belgium; {3}Lam Research Corporation, United States

<Abstract>
We investigate void nucleation and growth during electromigration (EM) in 30 nm half pitch Cu lines. Diffusion interfaces are varied by using SiCN cap or a CoWP metal cap, and by tuning the thickness of barrier metal. The EM failure modes are dependent on the cap materials but not on the barrier thickness. For CoWP capped Cu lines, since Co can diffuse into the interface between the barrier metal and Cu, both Cu diffusivities at the cap and barrier interfaces are suppressed. A CoWP cap is beneficial to EM for advanced interconnects where thinner barrier metals are required.

15:00-15:25

3-4 ***AC and Pulsed-DC Stress Electromigration Failure Mechanisms in Cu Interconnects***

Ming-Hsien Lin, Anthony S. Oates
Taiwan Semiconductor Manufacturing Company. Ltd., Taiwan

<Abstract>
The effects of AC and pulsed-DC (PDC) waveforms on electromigration failure distributions in Cu / low-k interconnects are examined. No failures are observed with a 1MHz pure AC stress, consistent with average current density controlled kinetics and complete recovery of damage during current reversal. Failure distributions with PDC stress are consistent with a degradation process that is determined by average current density and void growth kinetics.

15:25-15:45 **Break**