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Crack/Damage evaluation and micro-materials fabrication in the relation with electric field

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Evaluation of materials subjected to electric current and Joule heating has been studied by many researchers and fruitful results have been reported. In my presentation, crack problems in a conductive material are first discussed. The path-independent integral for an electric crack problem in a plate subjected to current is explained with its relations to Joule heating near the crack tip and the increase in electric resistance of the plate due to a unit crack extension. Regarding nondestructive evaluation of cracks, highly sensitive direct current potential drop technique, that is closely coupled probes potential drop (CCPPD) technique, is explained with its principle and superior characteristics for evaluation of closed cracks. Also evaluation of multiple cracks is mentioned. In the second, a topic in the field of micro and nano materials evaluation is explained, which is a subject of electrical failure of a metallic nanowire mesh due to Joule heating. Characteristic nature of sequential melting of nanowires in the mesh is explained for respective conditions of current control and voltage control. Next, electromigration (EM) phenomenon, which is atomic diffusion due to electron flow in high density, in metallic thin-film materials related to reliability of integrated circuits is discussed, where the effect of passivation on damage suppression is focused. Finally, fabrication of micro materials of wire and sphere is explained as utilization of EM, where the effect of temperature caused by Joule heating on the shape of formed micro material is mentioned. In addition, the other phenomena of atomic migration such as stress migration and ionic migration are discussed in comparison with EM from a few points of view. Electric field and Joule heating are connected with materials science and evaluation on many equipments, machines and structures. As written above, four topics related to these physical quantities are reviewed in this presentation.

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Biography

Masumi Saka received his Bachelor of Engineering degree in 1977 and his Doctor of Engineering degree in Mechanical Engineering in 1982, both from Tohoku University, Sendai, Japan. He became a Professor at Tohoku University in 1993. His research interests lie in the evaluation of materials system and the fabrication of metallic micro- and nano-materials. He is Editor of a book entitled "Metallic Micro and Nano Materials".

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