Post-breakdown conduction in MOS devices: from physical models to circuit applications

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When the gate oxide of a MOS structure is subject to electrical stress, traps or defects are progressively generated within the material, a process that eventually leads to its dielectric breakdown. This event is characterized by an abrupt or progressive change of conduction mechanism, from area distributed to a highly localized leakage current, depending on the oxide thickness and stress voltage. Even though the failure statistics of thin oxide layers has been shown to be consistent with percolation models of defects generation, much less is known about the physics of the post-breakdown phenomenon. In the last decade, a number of models based on mechanisms such as variable range hopping, direct tunneling, percolation and quantum point contact conduction have been proposed to explain the electron transport through the oxide layer under such circumstances. We will review the physics associated with these models as well as discuss their potential use in circuit simulators. We will see how the ocurrence of one or several breakdown event affects the normal behavior of devices.

Biography of Enrique Miranda

Enrique Miranda was born in Buenos Aires, Argentina, in 1963. He received the PhD degrees in Electronics Engineering and Physics from Universitat Autònoma de Barcelona (UAB), Spain and Universidad de Buenos Aires (UBA), Argentina in 1999 and 2001, respectively. From 1987 to 2003, he was Associated Professor at the Faculty of Engineering-UBA and from 2001 to 2003, Associated Researcher of the National Council of Science and Technology-CONICET, Argentina. Since 2004, he is Professor at the Escola Técnica Superior d'Enginyeria-UAB. Dr. Miranda has received research fellowships from: Spanish International Cooperation Agency-AECI: INTERCAMPUS (Universidad de Zaragoza) and MUTIS (UAB), German Exchange Academic Agency-DAAD (Technical University Hamburg-Harburg), italian government (Universita degli Studi di Padova), Ministerio de Ciencia y Tecnología, Spain: RAMON y CAJAL (UAB), MATSUMAE (Tokyo Institute of Technology, Japan), and TAN CHIN TUAN (Nanyang Technological University, Singapore). He has authored and co-authored 80 papers in international journals. Dr. Miranda serves as Editorial Advisor of the journal Microelectronics Reliability and is member of the Distinguished Lecturer program of the IEEE-Electron Devices Society. He has served in the technical committees of INFOS'07 and IRPS'08. His research interests include dielectric physics and reliability.