Interconnects Beyond Cu

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Power consumption by Cu interconnects (i.e., the on-chip metallic wiring) is an issue of critical concern for current CMOS technology. At the 45 nm-node, communications power consumption achieved parity with that of semiconductor operation and this will increase to 79% of the total power at the 7 nm-node. Looking to the future, Cu interconnect technology will continue to be the primary bottleneck, with the majority of the power consumed by the smallest, device level interconnects due to their greater numbers. This is a largely unaddressed problem. While much of the work in the semiconductor community has focused on novel three wire electronic logic devices for increased energy efficiency, the more urgent need for better wires at the device level has only been addressed by incremental improvements. The increased power consumption in Cu interconnects is a consequence of the resistivity size effect, wherein conductors with dimensions near or below the mean free path of electrons (39 nm for Cu at room temperature) exhibit higher resistivity than bulk conductors and thus higher "I^2R" losses. The resistivity size effect was first reported by Thompson in 1901. Its importance to Cu interconnects was identified in the 1990s and has been of concern to the semiconductor community since then. In this talk, I will present our studies of the impact of surfaces and grain boundaries on Cu resistivity, and demonstrate the anisotropy of the resistivity size effect in oriented single crystal nanowires of W. In addition, I will discuss the future of interconnects beyond Cu.

Bio: Barmak obtained her B.A. (First Class Honours) and M.A. degrees in Natural Sciences, Metallurgy and Materials Science from the University of Cambridge, England in 1983. She completed her M.S. in Metallurgy and Ph.D. in Materials Science at the Massachusetts Institute of Technology in 1985 and 1989, respectively. She received an AT&T Foundation Fellowship during her doctoral studies. Prior to her appointment to the Faculty at Lehigh University in 1992, she spent three years at IBM T. J. Watson Research Center and IBM East Fishkill development laboratory working on materials, structures and processes for field effect and bipolar junction transistors. She joined the Department of Materials Science and Engineering at Carnegie Mellon University in 1999 and was promoted to the rank of Full Professor in 2002. She received the National Young Investigator (NYI) award in 1994 and the Creativity Award in 2001, both from the National Science Foundation. She was a Meeting Chair for the Spring 1999 meeting of the Materials Research Society (MRS) and served as a member of the MRS Council from 1998-2000. She was a Meeting Co-Chair of the 13th Joint Magnetism and Magnetic Materials and International Magnetics Conference in 2016. She has co-edited and authored three chapters in a book on Metallic Films. Barmak joined Columbia University in 2011 as the Philips Electronics Chair of Applied Physics and Applied Mathematics, and Materials Science and Engineering. She has been the Director of the Materials Science and Engineering Program since 2013.