Device Technology for 3nm and Beyond, *Jin Cai, TSMC*

Jin Cai received the B.S. degree in physics from Fudan University, Shanghai, China and the M.S. and Ph.D. degrees in electrical engineering from University of Florida, Gainesville, FL. In September 2000, he joined IBM T. J. Watson Research Center at Yorktown Heights, NY in the silicon technology department. He worked on exploratory device research and technology pathfinding, and contributed to several generations of advanced CMOS technology development. In June 2015, he joined TSMC in Hsinchu, Taiwan. He is currently a deputy technical director in Corporate Research. He has published in international conferences and IEEE journals in the areas of strained silicon CMOS, fully depleted SOI CMOS, low-pow device and circuits, lateral SOI bipolar and tunneling field-effect transistors. He is an author of a book chapter and over 60 papers. He was granted over 60 US patents. He is a senior member of IEEE and served as an associate editor for IEEE Electron Device Letters from 2008 to 2017.

Abstract: The advent of FinFET technology ushered in a new era of transistor scaling where channel geometry became the main driver for gate length scaling. Transistor density scaling has been augmented by design-technology co-optimization to keep CMOS circuit density improvement unabated over the past decade. In this short course, we will focus on the main device options for 3nm which include the incumbent FinFET technology and the emerging nanosheet option. Contacted gate pitch scaling puts pressure on gate length and contact length scaling. Innovations in gate stack, S/D contact, and channel mobility continue to improve FinFET performance. The nanosheet option brings some relief for gate length scaling but faces new integration challenges and device design limits. In the longer term, geometrical scaling for all bulk materials will hit a limit. Naturally-thin materials, such as 2D layered materials and carbon nanotubes, provide the ultimate channel geometry. These new channel materials will be discussed at the end of this short course.