

Future of Silicon Integrated Circuit Technology

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Among numerous great inventions made in the 20th century, electronics is the most important one. According to a recent survey, ‘Electronic End Equipment’ has become the base of all human political and economical activities staked a share of the world’s total GDP of about 30,000 billion US dollars. Almost every thing related to human activities, such as power generation, transportation, entertainment, medical care, is now provided and controlled by electronics. Semiconductor, being the key component of the ‘Electronic End Equipment’, is a strategically important technology for all countries.

The semiconductor electronic circuit development has been accomplished with the downscaling of component size since the replacement of vacuum tubes with transistors 40 years ago. The circuit characteristics have benefited a lot from the downsizing. We are now able to integrate millions of CMOS transistors in the nanoscale in a silicon chip with few centimeters square. The CMOS integrated circuits as well as their core device technology are expected to evolve further for at least a couple of decades and their importance will be further increased in future intelligent society.

Recently, CMOS downsizing has been accelerated very aggressively in both production and research level, and even transistor operation of a 5 nm gate length CMOS was reported in a conference. However, many serious problems are expected for implementing small-geometry MOSFETs into large scale integrated circuits even for 45 nm technology node, and it is questionable whether we can successfully introduce sub-10 nm CMOS LSIs into market or not because of many reasons such as insufficient current drive and huge manufacturing cost. This paper reviews the challenges of nano-CMOS downsizing and manufacturing. We shall focus on the recent progress on the key technologies for the nano-CMOS IC fabrication in the next fifteen years. Then, possible limitation for the downscaling of CMOS and post downscaled CMOS technologies are discussed from many aspects.

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