

Four decades of developments in microelectronics: achievements and challenges

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The electronic industry has grown to be the largest in the world, with global sales of over one trillion US dollars. The foundation of the electronic industry is the silicon-based microelectronics.

The microelectronic era began in 1961 with the invention of the silicon monolithic integrated circuit by R. Noyce. In the past 40 years, there were many achievements in the microelectronics industry, including:

- the developments of CMOS (1963), the nonvolatile semiconductor memory (1967), DRAM (1968), and the microprocessor (1971);
- phenomenal progress in design and process technology with over 100 times reduction in minimum feature length and one million times increase in DRAM density; and
- the enormous expansion of the global market with 400 times increase in sales volume and 10 billion times increase in annual shipment of transistors.

As we continue device miniaturization, we now face many fundamental, practical, and economic challenges including the lithography limitation, interconnect parasitics, design complexity, and capital cost. We must develop innovative technologies and products to overcome these challenges and to move successfully toward the nanoelectronics.