Invited Paper

Latest Developments Toward a Carbon Nanotube Transistor Technology

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As the electronics community becomes increasingly aware of the impending end of scaling for silicon-based transistors, interest is growing in the search for a supplemental or replacement material that can continue the scaling trend. Carbon nanotubes (CNTs) have been heralded as an ideal 1D channel material for the post-Si transistor era, receiving a high volume of attention in the early to mid 2000s. Unfortunately, many researchers falsely concluded that carbon nanotube field-effect transistors (CNTFETs) met insurmountable obstacles, or could not deliver sufficient performance to warrant further consideration. In reality, the reduction in CNTFET research was primarily related to a shift in focus to another carbon allotrope—graphene. It is now understood that graphene poses no real prospects as a digital switch and that research of one carbon allotrope should never have siphoned attention from another—arguably more useful and ideal—allotrope for electronic applications. Despite the lower volume of research efforts, tremendous progress has been made in the last few years toward a CNT-driven transistor technology, including advances in device scaling, circuit demonstration, CNT purification, and CNT placement.

In this talk, the motivations for pursuing a CNTFET technology for high-performance digital computing will be reviewed. These include the demonstrated scalability of the channel length to sub-10 nm and operation at low supply voltage. Some industry research labs have cited that their abandonment of CNTFETs is based on metrics such as mobility; these notions will be analyzed and put into the proper context to show which performance metrics are pertinent for properly benchmarking CNT devices. The remaining obstacles to realizing a CNTFET technology will then be considered along with the latest developments toward overcoming each obstacle. By candidly reviewing these remaining challenges, it is hoped that those in attendance may develop new ideas to contribute to addressing them. Overall, whether or not we see a CNTFET technology should no longer be based on a debate about the now demonstrated scalability and performance, but whether we choose as a community to apply sufficient resources for overcoming the challenges toward realizing these deliverables.