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Researchers produce industry's first 7nm node test chips

July 9 2015

Dr. Michael Liehr (left) of SUNY Polytechnic Institute's Colleges of Nanoscale Science and Engineering and Bala Haran (right) of IBM Research inspect a wafer comprised of 7nm (nanometer) node test chips in a clean room in Albany, NY. IBM Research, working with alliance partners at SUNY Poly CNSE, has produced the semiconductor industry’s first 7nm node test chips with functional transistors. Credit: Darryl Bautista/Feature Photo Service for IBM

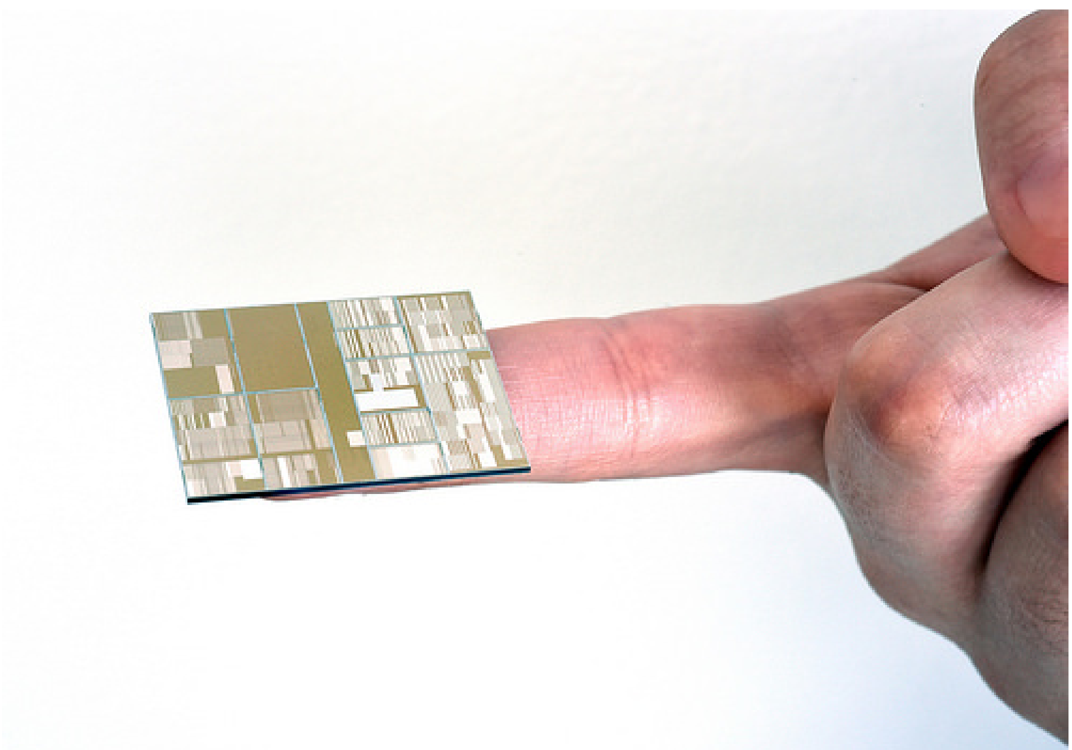
An alliance led by IBM Research today announced that it has produced the semiconductor industry's first 7nm (nanometer) node test chips with functioning transistors. The breakthrough, accomplished in partnership with GLOBALFOUNDRIES and Samsung at SUNY Polytechnic Institute's Colleges of Nanoscale Science and Engineering (SUNY Poly CNSE), could result in the ability to place more than 20 billion tiny switches—transistors—on the fingernail-sized chips that power everything from smartphones to spacecraft.

To achieve the higher performance, lower power and scaling benefits promised by 7nm technology, researchers had to bypass conventional semiconductor manufacturing approaches. Among the novel processes and techniques pioneered by the IBM Research alliance were a number of industry-first innovations, most notably Silicon Germanium (SiGe) channel transistors and Extreme Ultraviolet (EUV) lithography integration at multiple levels.

Industry experts consider 7nm technology crucial to meeting the anticipated demands of future cloud computing and Big Data systems, cognitive computing, mobile products and other emerging technologies. Part of IBM's $3 billion, five-year investment in chip R&D (announced in 2014), this accomplishment was made possible through a unique public-private partnership with New York State and joint development alliance with GLOBALFOUNDRIES, Samsung, and equipment suppliers. The team is based at SUNY Poly's NanoTech Complex in Albany.

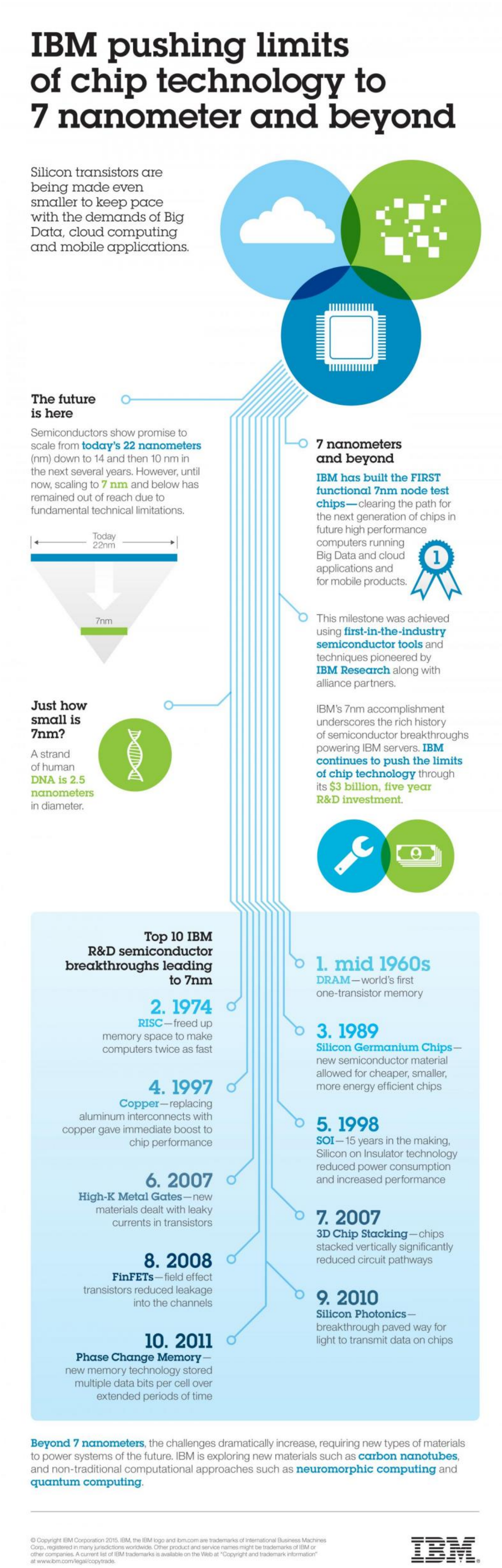
"For business and society to get the most out of tomorrow's computers and devices, scaling to 7nm and beyond is essential," said Arvind Krishna, senior vice president and director of IBM Research. "That's why IBM has remained committed to an aggressive basic research agenda that continually pushes the limits of semiconductor technology. Working with our partners, this milestone builds on decades of research that has set the pace for the microelectronics industry, and positions us to advance our leadership for years to come."

Microprocessors utilizing 22nm and 14nm technology power today's servers, cloud data centers and mobile devices, and 10nm technology is well on the way to becoming a mature technology. The IBM Research-led alliance achieved close to 50 percent area scaling improvements over today's most advanced technology, introduced SiGe channel material for transistor performance enhancement at 7nm node geometries, process innovations to stack them below 30nm pitch and full integration of EUV lithography at multiple levels. These techniques and scaling could result in at least a 50 percent power/performance improvement for next generation mainframe and POWER systems that will power the Big Data, cloud and mobile era.



Close up of IBM 7nm node test chip produced at SUNY Poly CNSE in Albany, NY. Credit: Darryl Bautista/Feature Photo Service for IBM

"Governor Andrew Cuomo's trailblazing public-private partnership model is catalyzing historic innovation and advancement. Today's announcement is just one example of our collaboration with IBM, which furthers New York State's global leadership in developing next generation technologies," said Dr. Michael Liehr, SUNY Poly Executive Vice President of Innovation and Technology and Vice President of Research. "Enabling the first 7nm node transistors is a significant milestone for the entire semiconductor industry as we continue to push beyond the limitations of our current capabilities."


IBM pushing limits of chip technology to 7 nanometer and beyond
Silicon transistors are being made even smaller to keep pace with the demands of Big Data, cloud computing and mobile applications.
The future is here
Semiconductors show promise to scale from today's 22 nanometers (nm) down to 14 and then 10 nm in the next several years. However, until now, scaling to 7 nm and below has remained out of reach due to fundamental technical limitations.
Today 22nm
7nm
7 nanometers and beyond
IBM has built the FIRST functional 7nm node test chips—clearing the path for the next generation of chips in future high performance computers running Big Data and cloud applications and for mobile products.
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This milestone was achieved using first-in-the-industry semiconductor tools and techniques pioneered by IBM Research along with alliance partners.
Just how small is 7nm?
A strand of human DNA is 2.5 nanometers in diameter.
IBM's 7nm accomplishment underscores the rich history of semiconductor breakthroughs powering IBM servers. IBM continues to push the limits of chip technology through its $3 billion, five year R&D investment.
Top 10 IBM R&D semiconductor breakthroughs leading to 7nm
1. mid 1960s
DRAM—world's first one-transistor memory
2. 1974
RISC—freed up memory space to make computers twice as fast
3. 1989
Silicon Germanium Chips—new semiconductor material allowed for cheaper, smaller, more energy efficient chips
4. 1997
Copper—replacing aluminum interconnects with copper gave immediate boost to chip performance
5. 1998
SOI—15 years in the making, Silicon on Insulator technology reduced power consumption and increased performance
6. 2007
High-K Metal Gates—new materials dealt with leaky currents in transistors
7. 2007
3D Chip Stacking—chips stacked vertically significantly reduced circuit pathways
8. 2008
FinFETs—field effect transistors reduced leakage into the channels
9. 2010
Silicon Photonics—breakthrough paved way for light to transmit data on chips
10. 2011
Phase Change Memory—new memory technology stored multiple data bits per cell over extended periods of time
Beyond 7 nanometers, the challenges dramatically increase, requiring new types of materials to power systems of the future. IBM is exploring new materials such as carbon nanotubes, and non-traditional computational approaches such as neuromorphic computing and quantum computing.
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Credit: IBM

The 7nm node milestone continues IBM's legacy of historic contributions to silicon and semiconductor innovation. They include the invention or first implementation of the single cell DRAM, the Dennard Scaling Laws, chemically amplified photoresists, copper interconnect wiring, Silicon on Insulator, strained engineering, multi core microprocessors, immersion lithography, high speed SiGe, High-k gate dielectrics, embedded DRAM, 3D chip stacking and Air gap insulators.

Provided by IBM

Citation: Researchers produce industry's first 7nm node test chips (2015, July 9) retrieved 3 August 2024 from https://phys.org/news/2015-07-industry-7nm-node-chips.html