

PNNL signs cooperative research agreement

Scientists at Pacific Northwest National Laboratory, the Oak Ridge National Laboratory and Motorola Labs have entered a cooperative research and development agreement, called a CRADA. The agreement is aimed at increasing the speed of future generations of integrated circuits.

Together, the scientists will pursue new materials that they believe may overcome a fundamental physics problem that threatens to limit future semiconductor improvements, and for which the semiconductor industry currently has no solution.

For decades, the semiconductor industry has been able to continue increasing the amount of circuitry on a chip while reducing its size — enabling smaller, faster and better electronic products. However, researchers have long known that the industry will eventually hit a wall that will prevent semiconductor designers from achieving additional size reduction.

The problem lies with the current gate insulating material, a layer of silicon dioxide the thickness of 25 individual silicon atoms. The silicon dioxide layer “gates” the electrons, controlling the flow of electricity across the transistor.

Each time the chip is reduced in size, the silicon dioxide layer must be proportionally thinned. At some point, however, the silicon dioxide will no longer be able to provide effective insulation from the effects of quantum tunneling, which is the natural tendency of electrons to flow across thin barriers or thin insulators.

To develop an effective gate insulator, most industry experts predict the need to develop new materials, so ORNL and Motorola Labs have been developing crystalline oxides on silicon and other semiconductor materials.

In 1999, Motorola demonstrated the world’s thinnest functional transistor by growing a strontium titanate crystalline material on a silicon substrate.

“By using crystalline oxides, we’re able to eliminate one of the hurdles to continuing the current rate of growth in the semiconductor industry,” said Rodney McKee of ORNL’s Metals and Ceramics Division.

The three-year research agreement has two phases. The first will involve transferring the details of ORNL’s patented crystalline oxide on silicon process to Motorola Labs and PNNL. The second phase includes testing and optimizing the technology.

Oak Ridge and Pacific Northwest are both Department of Energy multi-program laboratories. Motorola Labs is the advanced research arm of Motorola, Inc. and also licenses technologies to external customers. ♦