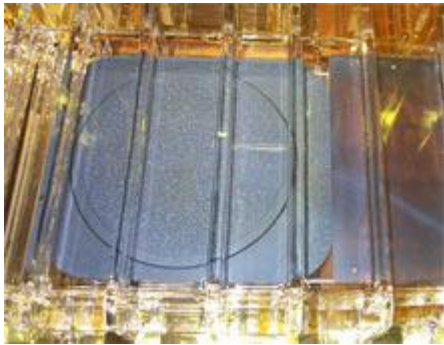


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Adding Speed to Silicon

A new way to grow various semiconductors on silicon could speed up electronics.

By Kate Greene



Fixing fissures: Usually when semiconductors, such as germanium, are grown on silicon, they crack due to strain caused by a crystal mismatch between the two materials. AmberWave is proposing a new way to grow germanium and other semiconductors on silicon so that they don't crack. Above, germanium is grown on an eight-inch silicon wafer. Credit: Amberwave

Silicon is the material of choice in the electronics industry, but there are other semiconductors that, if grown on a silicon wafer, could make transistors twice as fast. The problem is, these semiconductors are largely incompatible with silicon. But now a startup called [AmberWave Systems](#) has developed a new method for matching the different materials that could lead to faster, smaller electronics. Additionally, combining the different types of semiconductors could lead to cheaper lasers and other photonic devices, since the semiconductors used to make lasers and detectors are more expensive.

For decades, researchers have been trying to effectively grow various types of nonsilicon semiconductors on silicon, but so far, no technique has made it much farther than the lab. The fundamental problem, says Anthony Lochtefeld, AmberWave's vice president of research, is that atoms in silicon are spaced closer together than are those in semiconductors such as germanium, gallium arsenide, and indium phosphide. "The [atomic] lattices don't fit," says Lochtefeld, and the materials physically crack, which "prevents you from making anything useful."

In research presented at the [SEMICON West](#) conference in San Francisco last week, Lochtefeld showed how his team carved 500-nanometer-deep trenches (they range from about 250 to 400 nanometers wide) into a layer of silicon dioxide on silicon and then filled the trenches with germanium. At the bottom of the trench, the germanium predictably fissured where it contacted the silicon. However, due to the innate orientation of germanium's crystal lattice, as well as that of silicon, these cracks only crept up to about half the height of the silicon dioxide trench. "With a high enough sidewall," says Lochtefeld, "you can trap the dislocations." Above the trench, usable germanium was able to grow relatively defect-free.

AmberWave's work is an "exciting development," says [John Bowers](#), a professor of electrical and computer engineering at the University of California, Santa Barbara. "Their approach is promising and will hopefully yield material that's useful."

However, at this point, AmberWave's technology is still in its early stages, and the researchers have yet to prove that their method will yield working devices. Right now, the team is focused on testing other semiconductor materials, such as indium phosphide, which is used to make [infrared](#) lasers found in telecommunications networks. Lochtefeld doesn't expect to encounter surprises with the material because its lattice has similar spacing to that of germanium and gallium arsenide, another material successfully tested. But before the technology can be used to build transistors or photonic devices, there is still more work to do to ensure that the defects for each material are minimized.

Lochtefeld is optimistic that AmberWave's technology will find its way into transistors and photonics as early as the beginning of the next decade. The dimensions of transistors are shrinking, and silicon, as it's used today to make these transistors, will not be able to scale down and maintain the same speed. The industry estimates that silicon will reach its physical limitations by about 2012, and there's a scramble to find the best materials to replace it. (See "[Beyond Silicon](#).") "People have been going after this for 20 years," says Lochtefeld, "and for some very important applications, we think we've found a way to make this work."