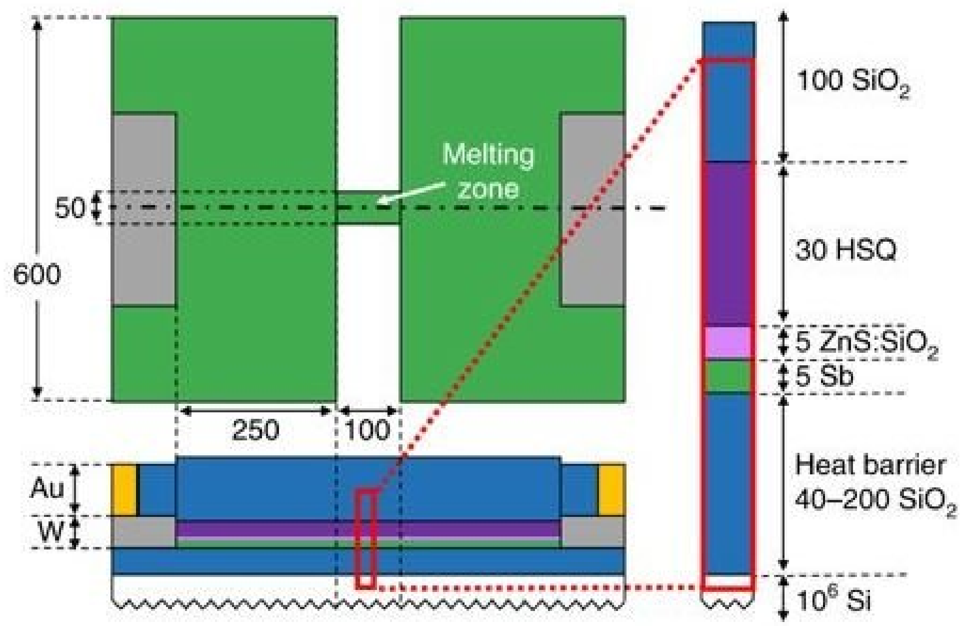
New design of PCM offers miniaturized memory cell volume down to 3nm

June 26 2018, by Bob Yirka



Device geometry with dimensions given in nanometres. HSQ, hydrogen silsesquioxane. Credit: *Nature Materials* (2018). DOI: 10.1038/s41563-018-0110-9

A team of researchers with members from IBM Research-Zurich and RWTH Aachen University has announced the development of a new PCM (phase change memory) design that offers miniaturized memory cell volume down to three nanometers. In their paper published in the journal *Nature Materials*, the group describes their new monatomic PCM and its advantages. Wei Zhang and Evan Ma with Xi'an Jiaotong University and Johns Hopkins University respectively offer a News & Views piece on the work done by the team in the same journal issue.

The need to store more data has become a pressing issue, Zhang and Ma note—global need doubles every year and is expected to grow to 44 zettabytes by 2020 and to 160 zettabytes by 2025. The problem is that current technology will not be able to handle that kind of growth because memory cells need to be smaller than are possible now—otherwise, storage will become unwieldy and much more expensive. For that reason, computer scientists have continued to look for new types of technology that store more in less space. One such technology involves using PCMs.

PCMs are a type of non-volatile RAM which exploit the unique properties of chalcogenide glass. They tend to be created using a mix of alloys doped to produce desired effects. They can be used to hold digital data by exploiting the resistance between an ordered crystalline phase and a disordered amorphous phase, allowing for recording, holding and erasing data without the need for electricity. But until this new effort, it has been problematic scaling them down without causing deterioration in useful properties.

To overcome issues of deterioration, the researchers found a single element, antimony, that could be used rather than a host of alloys. Doing so removed the need for partitioning, which typically leads to degradation of performance over millions of cycles, as cells are made smaller. Using the single element, the team found they were able to use films just three to 10 nanometers thick. They also overcame cooling issues, reaching a rate of nearly 10^{10} Kelvin per second.

The researchers acknowledge that some issues have yet to be resolved, such as the short lifetime of the amorphous state, but suggest what they have found so far looks very promising.

More information: Martin Salinga et al. Monatomic phase change memory, *Nature Materials* (2018). DOI: 10.1038/s41563-018-0110-9

Abstract
Phase change memory has been developed into a mature technology capable of storing information in a fast and non-volatile way, with potential for neuromorphic computing applications. However, its future impact in electronics depends crucially on how the materials at the core of this technology adapt to the requirements arising from continued scaling towards higher device densities. A common strategy to fine-tune the properties of phase change memory materials, reaching reasonable thermal stability in optical data storage, relies on mixing precise amounts of different dopants, resulting often in quaternary or even more complicated compounds. Here we show how the simplest material imaginable, a single element (in this case, antimony), can become a valid alternative when confined in extremely small volumes. This compositional simplification eliminates problems related to unwanted deviations from the optimized stoichiometry in the switching volume, which become increasingly pressing when devices are aggressively miniaturized. Removing compositional optimization issues may allow one to capitalize on nanosize effects in information storage.