

the phospholipid coating prevents leakage and provides both a steady signal over time and cell viability after the measurement. The ease of fabricating several

independent devices also allowed the team to make simultaneous measurements on the same cell or at multiple sites on a cell monolayer. With the poten-

tial for attaining dimensions as small as 5 nm, these devices could become a useful new tool in electrophysiology.

**Tobias Lockwood**

### Inverse spin Hall effect observed in silicon

Designers of next-generation electronics are trying to take advantage of both the electron's charge and spin. The success of spintronic devices therefore hinges on the ability to convert between spin and charge currents. The direct spin Hall effect is typically used to probe spin-orbit coupling in these materials, but the technique cannot be applied to semiconductors with long spin lifetimes, such as indirect bandgap silicon. Researchers Kazuya Ando and Eiji Saitoh at Tohoku University in Sendai, Japan, have turned their attention to the inverse spin Hall effect (ISHE), which makes use of the high resistivity of semiconductors to detect tiny spin currents. Ando and Saitoh show that it is possible to study spin-orbit interactions using ISHE in otherwise unmeasurable systems.

As reported in the January 17 issue of the online journal *Nature Communications* (DOI: 10.1038/ncomms1640), the researchers first deposited a thin-film heterostructure of  $\text{Ni}_{81}\text{Fe}_{19}/\text{B-doped Si}$  onto a silicon-on-insulator substrate and laid down ohmic AuPd contacts to detect the in-plane Hall voltage. They then measured the voltage across

the AuPd contacts with a magnetic field applied at  $0^\circ$  and  $180^\circ$  normal to the plane of the sample. They found that the Hall voltage depends on the direction of the magnetic field around the ferromagnetic resonance edge, which is indicative of the ISHE effect.

The researchers next measured the voltage dependence on the angle of the out-of-plane magnetic field. This revealed that a spin current is injected into the Si layer and that it precesses around an axis parallel to the applied magnetic field (see figure). Using the Landau-Lifshitz-Gilbert equation, Ando and Saitoh were able to demonstrate dynamical spin injection in *p*-type silicon at room temperature and unambiguously extract the ISHE contribution from the silicon layer. This technique can be used to explore the spin Hall effect in silicon with different dopants and doping levels, according to the researchers.

Moreover, the researchers said that their technique can be applied to understand other materials with weak spin-orbit interactions. This makes it particularly useful for spin-current

detection in semiconducting systems and opens many new areas for spintronics research.

**Steven Spurgeon**

### Particle-free silver ink prints small, high-performance electronics

University of Illinois at Urbana-Champaign (UIUC) materials scientists have developed a reactive silver ink for printing high-performance electronics on ubiquitous, low-cost materials such as flexible plastic, paper, or

fabric substrates. Jennifer Lewis, the Hans Thurnauer Professor of Materials Science and Engineering and director of the Frederick Seitz Materials Research Laboratory, and graduate student S. Brett Walker described the new ink in the January 25 issue of the *Journal of the American Chemical Society* (DOI: 10.1021/ja209267c; p. 1419).

Most conductive inks rely on tiny metal particles suspended in a solvent.

The new ink is formed from a transparent solution of silver acetate and ammonia through a modified Tollens' process. The silver remains dissolved in the solution until it is printed, and the liquid evaporates, yielding conductive features. The ink is composed of 22 wt% silver, comparable to other silver-precursor-based inks.

"It dries and reacts quickly, which allows us to immediately deposit silver as

