SPINTRONICS

Giant spin injection into semiconductor and THz pulse emission

Spintronics, which use the spin of electrons rather than their direct motion to carry information, has emerged as one of the leading alternatives to traditional electronics, promising faster information processing and lower energy consumption. Efficient spin injection into semiconductor is a crucial first step to realize useful spintronic devices, which remains an elusive challenge up to now. Recently, a joint group from Nanyang Technological University, the National University of Singapore, and the Agency for Science, Technology and Research (A*STAR) has achieved a breakthrough in the speed and efficiency of spin injection into semiconductor.

One member of the group has previously predicted the possibility of injecting massive ultrafast spin current across a ferromagnet/semiconductor interface. In this work, the joint group demonstrated the spin current injection experimentally. Ultrafast spin currents were generated by a laser pulse impinging on a Co film and injected into the adjacent monolayer MoS_2 — a two-dimensional semiconductor. Due to the high spin-orbit interaction of MoS_2, the injected ultrafast spin currents were converted into transient charge currents, leading to the THz pulse emission which can be readily detected and analyzed. A giant spin current was measured, which was about four orders of magnitude larger than typical injected spin current densities in previous bulk semiconductor devices. This work represents a significant step in the development of ultrafast spintronics, which could be benefical for high-speed spintronic computers in the future.

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FLEXIBLE SENSING SYSTEMS

Learning the signatures of the human grasp using a scalable tactile glove

Humans can sense, weigh and grasp different objects, deduce their physical properties at the same time, and exert appropriate forces – a challenging task for modern robots. Studying the mechanics of human grasping objects will play a supplementary role in visual-based robot object processing. These tools require large-scale tactile data sets with high spatial resolution. However, there is no large human-grasped tactile data set covering the whole hand, because dense coverage of the human hand with tactile sensors is challenging. Hence, the capability of observing and learning from successful daily human-object interactions is the long-term goal of aiding the development of robots and prosthetics.

A scalable tactile glove (STG) and deep convolutional neural networks with 548 sensors uniformly distributing over the hand has been fabricated to be used to identify individual objects and explore the typical tactile patterns by Subramanian Sundaram from Computer Science and Artificial Intelligence Laboratory, Massachusetts Institute of Technology, Cambridge, MA, USA. In their work, the STAG can record tactile videos, measuring normal forces in the range 30 mN to 0.5 N. More importantly, the device can be built with low-cost materials ($10) and used for a long time. They also record a large-scale tactile data set with 135 000 frames, while interacting with 26 different objects. The interaction between these groups and different objects reveals the key correspondence between different regions of human hands when manipulating objects. This as-fabricated artificial simulation lens of the natural mechanoreceptor network provides insight into the tactile characteristics of human beings, thus contributing to the design of prosthesis, robot grasping tools and human-computer interaction in the future.

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PLASMONIC LASERS

Perovskite plasmonic lasers capable of mode modulation

The plasmonic lasers can break down the diffraction limit of conventional optics to the deep subwavelength regime, thus the corresponding lasers have great potential applications in biological sensors, data storage, photolithography and optical communications. However, the mode modulation and ohmic losses are still the major problems that limiting the practical applications of the plasmonic lasers.

Recently, Wang Group developed a new method to synthesize perovskite nanowires by utilizing an electrochemical growth of lead oxide film in the solution method. The as-grown perovskite ($CH_3NH_3PbBr_3$) nanowires show a good growing repeatability and crystallinity. The according plasmonic lasers display a threshold of 62 $\mu J/cm^2$, narrow FWHM of 0.83 nm and high Q factor ($Q \approx 655$). The fast lasing decay time can be short as 1.6 ps. To be more significantly, the plasmonic lasing modes can be effectively manipulated by adjusting the pumping energy. Such characteristics are distinct from traditional Fabry-Perot cavity modes. In addition to the composition engineering of the gain materials, the output behavior presents a remarkable freedom for manipulating the plasmonic lasing modes. In brief, these results open a new way for manipulating the output performances of plasmonic laser, and of significance in the applications of multiplexed on-chip photonic devices, biochemical sensors, ultrahigh density data storage and super-resolution imaging devices.

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