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Dynamic defect-manipulation induced novel functionality in SnO_2

Disordered systems have been studied for scientific interest and also for unique potential applications. Recently, the conductance of a single-crystal SnO2 microrod on a flexible substrate was found to show reversible semiconductor-insulator transition by applying mechanical stress and an appropriate voltage. The decrease of the conductance is caused by the creation of lattice defects in mechanically bent microrods, because the defects work as trapping sites for carriers. With the increase of the stress, the strain leads to the formation of slip planes in the rutile structure. The microrod changes continuously from its normal semiconducting state to the insulating state by bending the flexible substrate. The insulating state is maintained after releasing the stress. Interestingly, the insulating state reverts to the original semiconducting state by the electrical healing of the defects. The transition can be tuned in a reversible and non-volatile manner. We applied this unique feature in SnO_2 microrods to the application of ultraviolet (UV) photodetector, and tried to solve the persistent photoconductivity (PPC) problem in wide-band-gap semiconductors, which originated from a very long lifetime of photo-excited electrons. We demonstrated one solution to the problem by high photoconductive gain (~1.5×10^9) and quick recovery speed (<1 s) of the simple SnO_2 microrod photoconductor. The quick recovery speed to the excited electrons with long life time was achieved by a novel "Reset" process: Bending and straightening the microrod and subsequently applying a voltage pulse. We also discuss about unique humidity sensing of the SnO_2-based core-shell devices.

Biography

Makoto Sakurai got his PhD from Keio University on the topic, "Magnetism And Structure of Magnetic Superlattice". He studied mechanism of atom-manipulation using scanning tunneling microscope (STM) and also developed a new technique of STM-induced light emission from atomic structures with the atom-resolved spatial resolution, as a researcher at RIKEN and NIMS. He is studying new functionality caused by dynamic defects-manipulation in wide-band-gap oxide nano/microstructures to achieve new-type computing architectures from 2007 and is also investigating for controlled self-assembly of peptide/molecules from 2013, as a Senior Researcher at NIMS.

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