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Room-temperature-protonation-driven optoelectronic device with water-gated thin-film-transistor structure

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Using the flexible valence state of transition-metal ions in transition metal oxides (TMOs), the optoelectronic properties can be largely controlled through the electronic phase transitions. Protonation of TMOs is one of the modulation techniques because the proton in TMOs acts as shallow donors to donate an electron into TM cations, resulting in a dramatic change in the optoelectronic properties. However, the protonation needs high-temperature heating process or electrochemistry in liquid electrolyte and thus it has not been suitable for the device application. In this talk, we propose a new approach of RT-protonation of TMOs by using a solid-state thin-film-transistor-type structure with “liquid-leakage-free water”, in which water is infiltrated in a nanoporous glass, as the gate insulator and demonstrate the RT-protonation-driven infrared (IR) transmittance tunable metal-insulator conversion device by using a thermochromic vanadium dioxide (VO₂) as the active channel layer. Alternative positive and negative gate-voltage applications induce the reversible protonation/deprotonation of VO₂ channel and the double-digit sheet-resistance modulation and 49% modulation of IR-transmittance were simultaneously demonstrated at RT by the metal-insulator phase conversion of VO₂ in a non-volatile manner. The present device is operable by the RT-protonation in all-solid-state structure and thus it will provide a new gateway for the development of functional optoelectronic devices.

Biography

Takayoshi Katase is currently working as an Associate Professor of Laboratory for Materials and Structures at Tokyo Institute of Technology, Japan. He obtained his BS from Tokyo Institute of Technology, Japan in 2007 and MS from Tokyo Institute of Technology, Japan in 2009 and a PhD from Tokyo Institute of Technology, Japan in 2012. In 2012, he worked as a Post-doctoral Researcher in FIRST Program, JSPS. In 2012, he worked as an Assistant Professor of Research Institute of Electronic Science, Hokkaido University, Japan. In 2016, he worked as a Researcher in PRESTO (Scientific Innovation for Energy Harvesting Technology), JST, Japan.

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