Material Design of Metal Oxide Nanowires and Their Promises

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Short Biography

Takeshi Yanagida is Professor of Institute for Materials Chemistry and Engineering at Kyushu University. He has working experiences as Researcher at Panasonic Corporation (April 1997 to August 1999), Research Associate, University of Teesside, (September 1999 to December 2002), JSPS Research Associate at Osaka University, (April 2003 to August 2005), Assistant Professor, Osaka University, (September 2005 to December 2009), Associate Professor, Osaka University, (January 2010 to December 2014), and current position- Professor, Kyushu University (January 2015 to present). He holds a BSc and MS in Chemical Engineering from Osaka Prefecture University, and PhD from Teesside University, England. His research interests are in Nanotechnology, Nanomaterials, Material Science and Their Novel Device Applications. Especially, he has established a unique strategy to create completely novel metal oxide nanomaterials (nanowires). He has been funded for several research projects from government and industry. Currently, he is working at national funding projects including ImPACT, CREST. He has received several scientific awards including, Young Researcher Award from APPIE, Award of Young Researcher, Society of Nano Science and Technology, Research Fellow of Hisyo Research in Osaka University, Funai Award, Young Research Award of Ministry of Education, Culture, Sports, Science & Technology in Japan. He has more than 200 publications including journal articles, proceedings, book chapters, and patents. He has been an invited speaker on numerous occasions at academic institutions throughout the world and at national and international conferences more than 100 times.

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Abstract

Self-assembled one-dimensional "Nanowires" have attracted much attention due to not only the fundamental interests in nanoscale-confided physical properties but also novel nano-device applications, where existing nanomaterials have not been applicable. Nanowires are attracting the interests of researchers from diverse research communities ranged from physics, chemistry, material science, electrical engineering, chemical engineering and others. Group VI and III-V compounds nanowires have demonstrated their great promises for exploring fundamental physical properties at nanoscale and also the feasibility of diverse nano-device applications. Although metal oxides exhibit their rich variety of

physical properties including photo catalysts, ferroelectric, ferromagnetic, high-Tc superconducting, memristive switching, which are hardly attainable to other materials, compared with group VI and III-V compounds nanowires, the feasibility of functional oxide nanowires has been strongly limited due to the absence of fabrication method for various transition metal oxide nanowires. Here we demonstrate i) "Material Design Concept" for well-defined oxide nanowires via vapor-liquid-solid (VLS) mechanisms, and ii) the memristive switching phenomena within a single oxide nanowire down to 10 nm scale. We have succeeded to fabricate a well-defined single crystalline metal oxide nanowire by controlling precisely formation environments. When comparing with MD simulations as to VLS growth, the importance of material transport via the metal catalysts has been found. Especially, we have found that the difference between LS interface and VS interface on the critical nucleation size essentially allows us to perform VLS nanowire growth. This knowledge can be expanded to discover novel metal oxide nanowires via VLS mechanisms. Next, we have constructed highly stable RS junctions comprised of Pt/single oxide nanowire /Pt. The nanowire memristor exhibited the endurance up to 10^8 by utilizing self-assembled nanowires and well-defined nano-gap electrodes. In addition, information as to the memristive switching including the carrier type for memristive switching and the spatial switching location, have been extracted by the present nanowire memristor, which had been buried in conventional memristors. We believe that the presented approaches by utilizing self-assembled oxide nanowire/metal junctions offer an important system and platform for investigating not only nanoscale confined physical properties of transition metal oxides but also exploring exciting novel nano-devices with other electric materials, which had not been possible.

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