Smart Materials Design to Ahieve Unique Advanced Functional Oxide Films

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Science and industry alike are realizing that oxides hold many interesting "frontier" properties: electrical, optical and antibacterial properties. We propose smart materials design to tailor film properties for their wide applications. The key factors for success are to control carrier concentration in a wide rage together with carrier transport, to widen band gap for the light emission with deep and vacuum UV regions, and to manipulate reactive oxygen species at the film surfaces. In addition, we have been developing a unique film growth apparatus, *reactive plasma deposition with dc arc discharge* (*RPD*). It enables us with low-temperature deposition of advanced oxide films exhibiting crystallized or amorphous states on amorphous glass or flexible polymer substrates. For the fabrication of high efficiency of 24.1% Si-based hetero-junctions solar cells, recently, we have succeed in the co-doping method using Ce and H atoms to achieve In_2O_3-based transparent electrodes exhibiting high Hall mobility of more than 145 cm^2/Vs and low free carrier absorption in the near-infra red wavelength spectral range. The processing temperature is of less than 200 ºC. The roles of Ce and H atoms are to generate free carriers together with suppressing the formation of oxygen vacancy (V_O). Very recently, we have been developing the state-of-the-art technology to generate and irradiate electronegative oxygen (O^-) ions. The use of O^- technology annihilates V_O or generates reactive oxygen species in the vicinity of surface of ZnO conductive films. The applications include H_2 gas sensors for a hydrogen society to protect the global environment and antibacterial materials for human health care. We will clarify what smart materials are.

Keywords—*carrier transport, electro-optical devices, oxides, wide-bandgap semiconductors*

Professional Biography

Tetsuya Yamamoto obtained a Ph.D. degree in theoretical condensed matter physics from Osaka University in 1997 and has been a professor of Kochi University of Technology since 2001. His area of expertise is in the oxide- and nitride-based semiconductor-film growth, the development of the film growth apparatus, characterization method, first-principles calculation and condensed matter physics theory of wideband-gap semiconductors such as AlN, GaN, ZnO and In_2O_3. He has been the supervisor of many national projects in Japan, and the Conference Chair and organizers of International Conferences and Symposium. He won the prize by the Ministry of Education, Culture, Sports, Science and Technology for his work on ZnO-based transparent-conductive oxide films for optoelectronic devices in 2011. He has published more than 135 papers in reputed journals since 1995 and has been serving as an editorial board member of Ceramics in Modern Technologies.



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