Division of Materials Chemistry
– Inorganic Photonics Materials –

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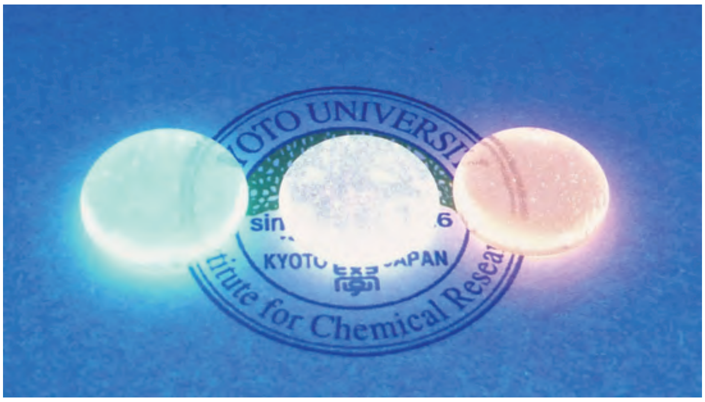
Scope of Research

In the laboratory, the main subject is to create novel functional amorphous materials such as organic-inorganic hybrids, polycrystalline and amorphous inorganic oxides. For obtaining such materials, the amorphous structure and the property are investigated by XRD, MAS NMR, thermal and optical analysis and quantum chemical calculations. Currently, we are trying to prepare novel amorphous-based optical functional materials such as proton conducting membrane, optical biosensor, and amorphous phosphor.

KEYWORDS

Amorphous Oxide Phosphor
Glass Structure
Organic-Inorganic Hybrids
Optical Biosensor
Environmental Remediation



Selected Publications

Masai, H.; Takahashi, Y.; Fujiwara, T.; Matsumoto, S.; Yoko, T., High Photoluminescent Property of Low-Melting Sn-Doped Phosphate Glass. *Applied Physics Express*, **3,** [082102-1]-[082102-3] (2010).

Masai, H.; Fujiwara, T.; Matsumoto, S.; Takahashi, Y.; Iwasaki, K.; Tokuda, Y.; Yoko, T., White Light Emission of Mn-Doped SnO-ZnO-P_2O_5 Glass Containing No Rare Earth Cation., *Optics Letters*, **36,** 2868-2870 (2011).

Masai, H.; Tanimoto, T.; Fujiwara, T.; Matsumoto, S.; Tokuda, Y.; Yoko, T., Correlation between Emission Property and Concentration of Sn^{2+} Center in the SnO-ZnO-P_2O_5 Glass, *Optics Express*, **20,** 27319-27326 (2012).

Ueda, Y.; Tokuda, Y.; Fujimura, S.; Nihei, N.; Oka, T., Removal of Radioactive Cs from Gravel Conglomerate Using Water Containing Air Bubbles, *Water Sci. Tech.*, **67,** 996-999 (2013).

Ueda, Y.; Tokuda, Y.; Goto, H.; Kobayashi, T.; Ono Y., Removal of Radioactive Cs from Nonwoven Cloth with Less Waste Solution Using Aqueous Sodium Metasilicate, *J. Soc. Remed. Radioact. Contam. Environ.*, **1,** 191-195 (2013).

Fabrication of Rare Earth-free Amorphous Oxide Phosphor

Glass is a solidified liquid that can possess characteristics of both solid and liquid. Although glass is an isotropic material from macroscopic viewpoint, it is indeed anisotropic in terms of microscopic scale. Various compositions of inorganic glasses bring a random network that allows diversity in local structure. The diversity is the origin of various functionalities of inorganic glass.

On the other hand, light emitting devices and various kinds of phosphors containing rare earth (RE) are being actively developed nowadays. However, the host materials for these phosphors still remain limited with respect to a high-power or short-wavelength excitation light source. If glass material without the RE cation shows light emission comparable to the crystalline phosphor, it will be considered a novel emitting material capable of much broader emission and good formability.

Recently, we have reported the highest quantum efficiency (QE) for amorphous SnO-ZnO-P_2O_5 glass. It is notable that the broad emission is brought about by Sn^{2+} center, and that the UV-excited emission efficiency is the largest efficiency of glass material without RE cation ever reported. Our group has also demonstrated white light emission of RE-free Mn-doped SnO-ZnO-P_2O_5 glass. The transparent glass showed blue ~ white ~ red emission, which depended on the amount of MnO (Figure.1). Because the high value of quantum efficiency is comparable to crystalline phosphor, it suggests that RE-free glass phosphor is very fascinating material from the viewpoint of unique emission mechanisms in a random matrix.

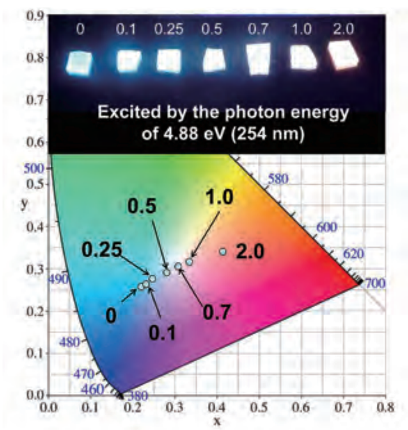


Figure 1. Chromaticity coordinates of the xMnO-2.5SnO-57.5ZnO-40P_2O_5 glasses. Inset shows a photograph of these glasses under exposure to the photon energy of 4.88 eV (254 nm).

Environmental Remediation

The Fukushima Daiichi Nuclear Power Station suffered a meltdown as a result of the Tohoku earthquake of March 11, 2011, in Japan. The accident released several kinds of radioactive elements over eastern Japan. It is well known that I-131, Cs-134, and Cs-137 are the main radioactive elements that pose a risk of human exposure (IAEA report 2006). Among these, Cs-134 and Cs-137 are the most important in terms of their effects on the environment because the half-life of I-131 is relatively short and other kinds of radioactive elements such as Pu-239 cannot spread far from the nuclear reactor (Eisenbud 1973). Therefore, removal of Cs-134 and Cs-137 from the environment is very important for protecting human health. Here, we report the effectiveness of water containing air bubbles with a diameter around 100 nm (nanobubbled water, NB water) for the removal of radioactive Cs. Laboratory experiments confirmed that NB water is more effective than purified water and as effective as water with neutral detergent in the removal of Cs-137 from gravel. Moreover, NB water retains its effectiveness even after storage for 7 days. Additionally, NB water produced from tap water was found to be effective for removal of radioactive Cs from gravel conglomerate in Fukushima, Japan.

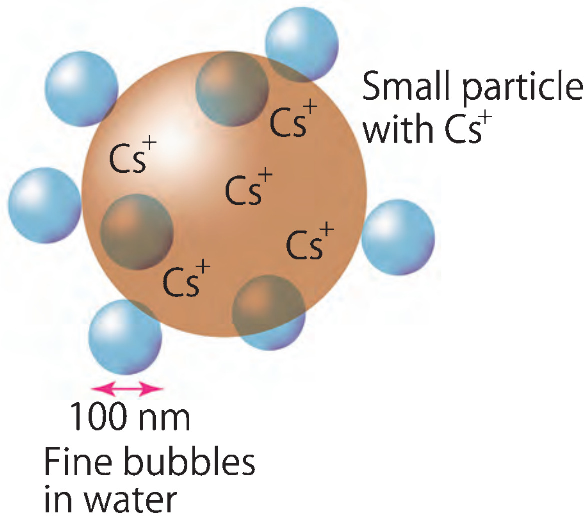


Figure 2. Schematic model of fine bubbles in water attached to clays. The fine bubbles were introduced into water by using centrifugal rotation method. The average diameter of the bubbles was determined as around 100 nm using a particle tracking analysis (NANOSIGHT LM-10, Quantum Design inc.). The mechanism for the removal of radioactive Cs is still unclear; several possibilities include surface adsorption, surface charge, and bubble nucleation. However, we consider that Cs was removed with clays.