Solid State Chemistry - Amorphous Materials-

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Visitor

Dr HEO Jong Pohang University of Science and Technology, Korea, 15 January 2000 – 14 Feburary 2001

Scope of Research

Amorphous and polycrystalline inorganic materials with various optical functions such as photorefractivity, optical nonlinearity, and photo-catalysis are the target materials in this laboratory, which in the forms of thin film and bulk are synthesized mainly by sol-gel, multi-cathode sputtering and sintering methods. The detailed correlation between structure and properties is extensively investigated to obtain highly functional materials by using X-ray diffraction techniques, high-resolution NMR, thermal analyses, various laser spectroscopies and ab initio molecular orbital calculations, and so on.

Research Activities (Year 2001)

Presentations

Preparation of organic-inorganic hybrid low-melting glasses, Niida H, Masai M, Takahashi M, Yoko T, Winter, Spring & Fall Meeting Ceramic Soc. Jpn 19 January, 23 March, 27 September, ICG, 2 & 3 July.

Photocatalysis in thin film TiO_2 electrodes, Takahashi M, Enkhtuvshin D, Mori R, Akita Y, Yoko T, Winter & Spring Meeting Ceramic Soc. Jpn 19 January, 23 March,Sol-Gel2001, 15 September. PacRim4, 6 November.

Photoresponce of doped and undoped silica glasses, Ichii K, Sako A, Takahashi M, Uchino T, Yoko T, Spring meeting, JSAP., 3 March, LPM2001, 17 May, Meeting on Glasses and photonics materials, 2 November, PacRim4, 6 November. BGPPGW, 4 July, ICG, 6 July

Dispersion of nonlinear absorption coefficients of tellurite glasses by nonlinear transmission spectroscopy, Tokuda Y, Takahashi M, Yoko T, ICG, 3 July, Fall meeting Ceramic Soc. Jpn, 27 September.

Novel pressure-induced polymorphic transition from fumed silica to transparent amorphous SiO_2 at room temperature Uchino T, Sakoh A, Azuma M, et al. AIRAPT-18 & HPCC-11, 24 July

Grants

Yoko T, Photochemical reactivity of glasses, Grant-in-Aid for Scientific Research (A) (2), 1 April 2001 - 31 March 2005.

Uchino T, Mechanism of defect formation and optical functions of silica glasses under irradiation of light, Grant-in-Aid for Scientific Research, Promotive Research (A) (2), 1 April 1999 - 31 March 2001.

Uchino T, Microstructure modification and photo-induced functions of amorphous silica, Precursory Research for Embryonic Science and Technology (PRESTO), 1 April 2001 - 31 March 2004.

Takahashi M, Development of photorefractive low-melting glasses, Grant-in-Aid for Scientific Research (B) (2), 1 April 2001 - 31 March 2005.

Takahashi M, Transient transition state of Ge-doped silica glass, Grant-in-Aid for Scientific Research Promotive Research (A) (2), 1 April 1999 - 31 March 2001.

Takahashi M, Development of active optical integrated

Topics

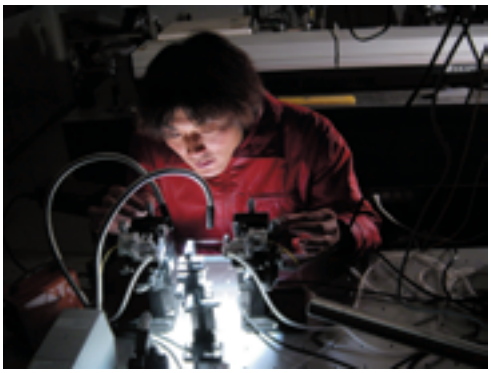
Preparation of low-melting hybrid glasses through non-aqueous acid-base reaction

Organic-inorganic hybrid glasses of new type low-melting glasses with a melting temperature of less than 200°C have been successfully prepared through a non-aqueous acid-base reaction. Such a low-melting hybrid glass has a bright prospect of finding many applications as advanced active photonics devices in addition to conventional low temperature glass-to-metal sealant because of the easy fabrication in the forms of optical fiber and waveguide and the high solubility of optically active organics.

Preparation of low-melting glass inside the dry-box.

Large photoreftactivity in Ge-doped silica glasses waveguide

High photorefractive glasses based on silicon dioxide are of great importance as materials for active/passive optical devices in the field of dense and rapid information processing systems. Glasses have long been playing a crucial role in the optical telecommunicating systems as optical fibers. All optical signal processing is, however, strongly required. For this reason, the development of glass materials with large photorefractivity is now the most vigorous field in the photonics community.



Measurements of transmission loss in waveguide by using fiber-coupling apparatus.

Very recently, we have succeeded in the preparation of high Ge-doped SiO_2 thin film with a very large photorefractivity of $\Delta n > 10^{-3}$ by the p-CVD process, which is one order of magnitude larger than the value reported so far. Based on the precise investigation of defect photochemistry in the Ge-doped silica glass by means of spectroscopy and computer simulations, it is clarified that the photosensitivity of Ge^{2+} species embedded in the glass during preparation process is the origin of photoactivity such as photorefractive and induced nonlinearity.

Photocatalysis in advanced TiO_2 film electrodes

Since the discovery of water decomposition on the illuminated TiO_2, a large number of works on the application and fundamental aspects of photo-catalytic effect of the TiO_2 electrode have been reported. They are mainly related to the self-cleaning, chemical energy generation, and photovoltaic devices. In order to realize TiO_2-based photocatalytic devices with a visible photo-response, we are trying to apply a new concept of effective carrier separation in the space charge layer to the preparation of TiO_2-based film electrode by using the sol-gel process and the multi-cathode helicon sputtering method.

Multi-cathode helicon sputtering apparatus and the preparation chamber (top view).

Grants (continued)

circuit based on oxide glasses, Industrial Technology Research Grant Program, NEDO, 1 November 1999 – 31 March 2003.

Takahashi M, Development of low-melting glasses with large photorefractivity, Nippon Sheet Glass foundation, 1 April 1999 – 31 March 2002.

Tokuda Y, Structure and optical nonlinearity of chalcogen-containing glasses, Grant-in-Aid for Scientific Research, Promotive Research, 1 April 1999 – 31 March 2003.

Donations from three companies and four private company foundations

Awards

Uchino T, Vittorio Gottardi Prize, Studies on the structure and properties of glasses, International Commission on Glass, 2 July.

Takahashi M, Award for young scientists, Studies on the optical properties and structure of photonic glasses, Ceramics Society of Japan, 17 May.

Niida H, A E Owen Student Poster Award First Prize, Preparation, properties and structure of organic-inorganic hybrid low-melting glasses, Society of Glass Technology, 6 July.