Solid State Chemistry
- Amorphous Materials -

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Dr M Singh NASA Glen Research Center, USA, 24 May, 2002

Scope of Research

In this laboratory, amorphous and polycrystalline inorganic materials with various optical functions such as photorefractivity, optical nonlinearity, and photo-catalysis are the target materials, which in the forms of thin film and bulk are synthesized mainly by the sol-gel, multi-cathode sputtering, melt-quenching and sintering methods. In order to obtain highly functional materials the detailed structure is extensively investigated 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 2002)

Presentations

Preparation and optical properties of organic/inorganic hybrid low-melting glasses, Masai H, Takahashi M, Yoko T, India-Japan Information Technology Discussion-Meeting, 15 March, Spring meeting Ceramic Soc. Jpn., 26 March, XIIIth International symposium on non-oxide glasses and new optical glasses, 12 September, Meeting on Glass and Photonics Materials, 22 November.

Photocatalysis of TiO_2 thin film electrodes, Mori R, Takahashi M, Yoko T, Spring meeting Ceramic Soc. Jpn., 23 March, Autumn meeting Chem. Soc. Jpn., 25 September.

Photosensitive GeO_2-SiO_2 films for UV laser writing of waveguides, Sakoh A, Takahashi M, Nishii J (AIST), Yoko T, Spring meeting Jpn. Soc. Appl. Phys., 29 March, Laser Precision Microfabrication, 27 May, Glass and optical materials division fall meeting, ACerS, 15 September, Meeting on Glass and Photonics Materials, 21 November.

Structural analysis of glasses using high-resolution NMR and ab initio molecular orbital calculation method, Tokuda Y, Miyabe D, Mizuno M, Yoko T, Glass and optical materials division fall meeting, ACerS, 15 September, Meeting on Glass and Photonics Materials, 22 November.

Optical properties of dielectric multilayer structures with the dual-periodicity, Akita Y, Shimada R, Takahashi M, Yoko T, Fall meeting Ceramic Soc. Jpn., 22 September, International workshop on PECS4, 29 and 30 October.

Waveguide formation in niobium tellurite glasses, Tokuda Y, Saito M, Takahashi M, Yoko T, XIIIth International symposium on non-oxide glasses and new optical glasses, 12 September.

Topics

Preparation of organic/inorganic hybrid low-melting glasses

C_{60}-doped low-melting glass

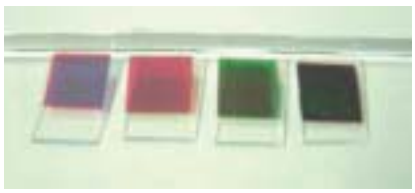
Organic/inorganic hybrid low-melting glasses free of pollution elements such as Pb and F, the use of which has been omitted from the viewpoint of environmental protection, are developed by using sol-gel melting and non-aqueous acid-base reaction processes. This new type of glass can contain a large amount of optically functional organic materials, which have high non-linear susceptibility at the optical communication wavelength (1.3~1.5 mm). A number of organic materials are examined to establish the optimum performance in these hybrid glasses. One example of such functional organic materials is fullerene (C_{60}), which has been successfully introduced into the present hybrid low-melting glass. The use of these materials renders the glass very suitable for many applications in photonic devices.

Photosensitive GeO_2-SiO_2 films for UV laser direct writing of waveguides

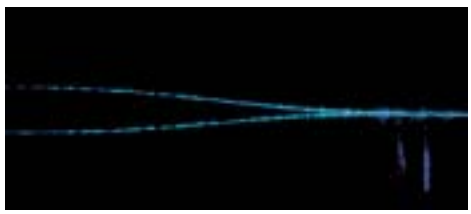
Recent results have suggested that p-CVD-deposited silica glass films doped with large amounts of GeO_2 exhibit a significant photorefractivity. In fact direct writing of channel waveguide structures in the p-CVD GeO_2-SiO_2 glass films have been successfully carried out implementing UV laser irradiation. A propagation of light with wavelengths of 488 nm and 1553 nm were experimentally confirmed with this channel waveguides.

Optical properties of dielectric multilayer structures with dual-periodicity

Dielectric multilayer structures with dual-periodicity have been found to exhibit several interesting features. Among them, a strong localized state of Bloch photons in a particular condition is expected to enhance the electromagnetic field. The dual-periodic multilayer structures consisting of SiO_2 and TiO_2 films, which are attained by modulating the thickness of TiO_2 layers with a high dielectric constant, was deposited on a silica glass substrate by helicon plasma sputtering. The transmission properties of these structures with different modulation parameters and their thermal response in the temperature region from RT to 200°C are examined aiming at the possible applications as an active switch.



The dual-periodic multilayer structures with various thickness-modulation parameters. These layers are clearly uniform and the colours are somewhat beautiful.



Y-branch channel waveguide directly written by UV laser irradiation. Ar^+ laser light (488nm) is coupled.

Grants

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

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

Takahashi M, Development of active optical integrated circuit based on oxide glasses, Industrial Technology Research Grant Program, NEDO, 1 November 1999 - 31 March 2003.

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

Takahashi M, Development of photorefractive low-melting hybrid glasses, Asahi Glass foundation, 1 April 2000 - 31 March 2002.

Takahashi M, Preparation of novel low-melting glasses through non-aqueous acid-base reaction, Izumi Scientific foundation, 1 October 2001 - 31 September 2002.

Takahashi M, Development of photonics materials based on the organic-inorganic hybrid low melting glasses, PRESTO, Japan Science and Technology, 1 November 2002 - 31 October 2005.

Shimada R, Study on optical devices using novel organic/inorganic hybrid low-melting glasses, Strategic Information and Communications R&D Promotion Scheme, Ministry of Public Management, Home Affairs, Posts and Telecommunications, 1 December 2002 - 31 March 2005.