나노크기의 금속미립자 분산 유리의 제조 및 결정특성
(Charaterization & Synthesis of Glass dispersed with Nano-sized metallic particles)

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1. Introduction Ag and Au cations in the glass are the typical metallic ions to have the photosensitivity by UV beam irradiation with the help of Ce^{3+} ion as a sensitizer. The electrons produced by the photo-ionization can reduce the ions to metallic particles that play a role of nuclei in the glasses. Then, the subsequent heat-treatment can develop the nanocrystalline consisting of the components in the glasses. This mechanism is mostly applied from the nucleation and crystallization in the photosensitive glasses irradiated by UV beam. In this presentation, we report Nd:YAG laser-induced Ag nano particle dispersed glass and crystallization by subsequent heat-treatment.

2. Experimental Procedure The Glass was prepared in Lithium Aluminum Silicate system with addition of AgCl and CeO_2 The batch was melted at 1550℃ for 2hrs, and cooled rapidly by being poured onto a carbon plate. The glass specimen were irradiated with 355nm wavelength of 3rd harmonic generated Nd:YAG laser. The parameters of the laser were 8ns pulse width, 10Hz frequency and 90mJ/pulse, and generated laser beam was irradiated to the glass specimens. After the irradiation, heat treatment at 400℃ for 1hr was carried out to precipitate Ag metallic particles in the glasses. We have observed growth of crystal phases in the glass with Optical Transmission Polarized Microscope(OTPM) and Scanning Electron Microscope (SEM). X-ray diffraction analysis and TEM were adopted to define crystals precipitated in the laser irradiated area in the glasses.

3. Results This phenomenon is due to the fact that the nucleation of laser treated glass has more nuclei with help of photochemical ionization, $Ce^{3+} + Ag^{+} \rightarrow Ce^{4+} + Ag^{0}$, by photons of laser, which creates Ag metallic particles acting as seeds in the glass. Thus, it is considered that laser-induced nucleation by photons and spontaneous nucleation by heat treatment occur in the laser-irradiated glass at the same time, but only the spontaneous nucleation is happened in non laser-irradiated glass. Generally, the two-step heat treatment for nucleation and crystallization is the typical process in most glass ceramics, but the proposed method for crystallization in this paper is to utilize laser induced nucleation followed by one-step heat treatment. Thus, we propose that the photo-ionization of Ce^{3+} by laser photons energy with 10-100mJ/cm^2 at 300-350nm wavelength, which is corresponding to ionization energy of Ce^{3+} by UV beam for creation of novel metallic particles in a photosensitive glass, offers nucleation by heat nucleation process in the glass.