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Time-resolved measurements of the photoirradiation effect in the ionic conductivity of the polycrystalline AgI

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[Introduction] Silver iodide (AgI) is one of the most intensively studied fast ionic conductors. It exhibits at least six crystalline polymorphs and undergoes phase transitions induced by the temperature and pressure. So far, we have investigated the control of the ionic conductivity in AgI by using light and external electric fields. The steady-state measurement of the reversible photoswitching behavior in bulk resistance and in color of polycrystalline AgI at room temperature has been reported recently by our group[1]. In the present work, the time-resolved measurements of the electrical conductivity have been carried out to elucidate the carrier dynamics in the ionic conductivity induced by photoirradiation in the polycrystalline AgI.

[Experimental methods] The pellets of AgI were prepared by grinding and then pressing the reagent powder uni-axially at 200 kgf/cm^2. Since, at ambient condition, β- and γ- phases coexist and just after the preparation the percentage of γ-component is higher, the pellets were immerged into KI solution to increase the percentage of the β-component. The γ-AgI samples were prepared by hard grinding and pressing AgI powder by 350 kgf/cm^2. To fabricate the electrodes, carbon paste was used. The samples were characterized by using the complex impedance spectra (Cole-Cole plots) in the frequency range between 42Hz and 5MHz with an impedance analyzer. A variable dc voltage supply and an oscilloscope were connected in series with the samples to perform time-resolved measurements of the photocurrent. A nano-second pulsed laser was used as a light source. The measurements were carried out at room temperature as well as at 77K with different excitation wavelengths.

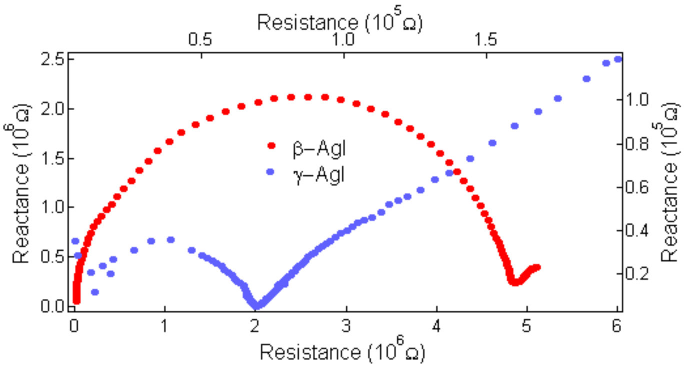

Fig 1: Impedance spectra of the β-AgI (left and bottom axes) and γ-AgI (right and top axes).

[Results and discussions] Fig. 1 shows the impedance spectra of β-AgI and γ-AgI. The samples were characterized as β- and γ- polymorphs from their bulk resistances. Fig. 2 represents the time profiles of the transient photocurrent in β-AgI obtained with the excitation of wavelength 532 nm for different voltages at room temperature (a) and at 77 K (b). The photocurrent increases with the increase in voltage. At higher temperature the photocurrent is

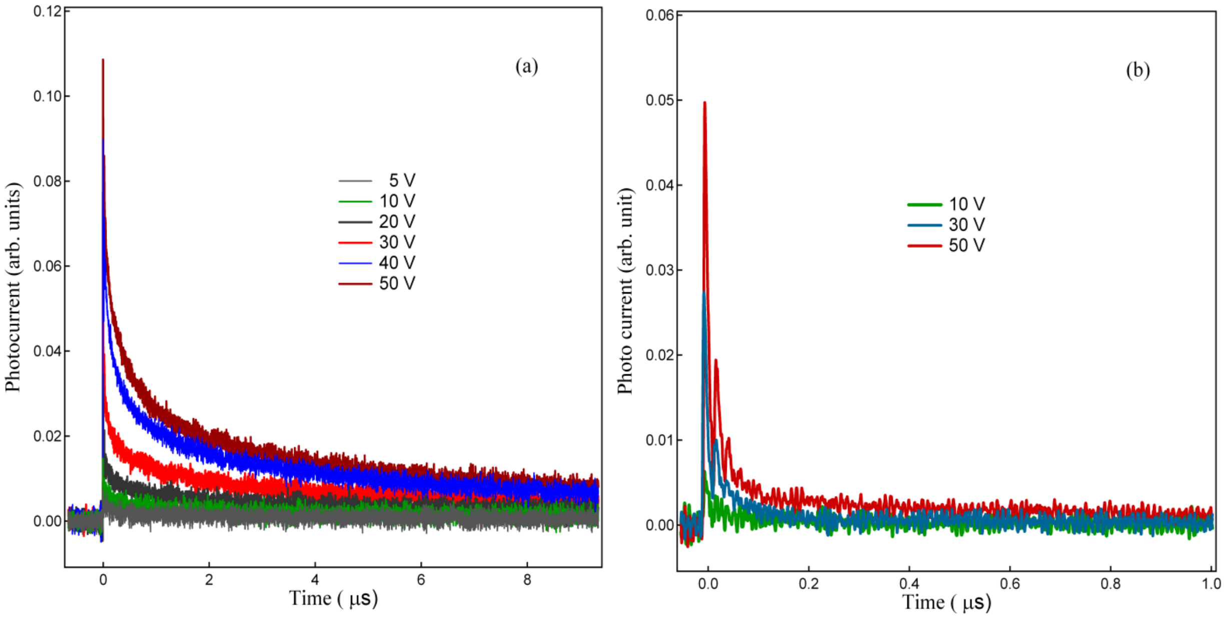

Fig. 2: The time profiles of the transient changes in the photocurrent of β-AgI obtained by the photoirradiation at the wavelength of 532 nm for different voltages at (a) room temperature and at (b) 77 K.

almost twice as large as that for lower temperature. At room temperature, the decay profiles show slower relaxation in comparison to those at 77 K. The peak heights of the transient photocurrent as a function of voltage for three different excitation wavelengths at room temperature are shown in Fig. 3. The peak height increases with the voltage for all excitation wavelengths but the enhancement shows significant excitation energy dependence. The decay profiles of the photocurrent of β- and γ-AgI are examined at different temperatures and electric field strengths. The excitation wavelength and laser power dependences of the conductivity will be discussed in detail.

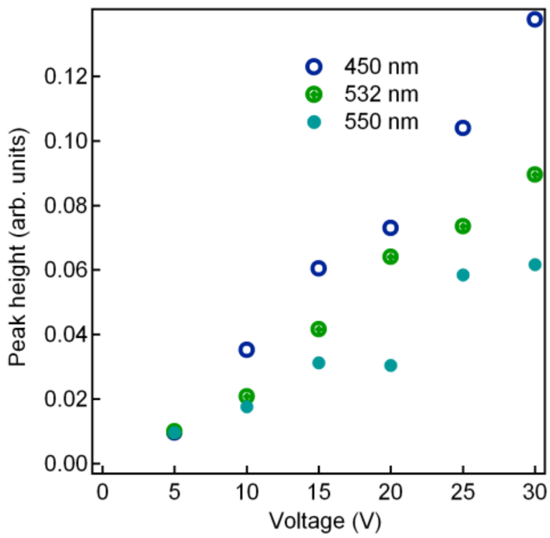

Fig. 3: Voltage dependence of the peak heights of γ-AgI for 450nm, 532nm and 550nm excitation wavelengths.

[Reference] [1] R. Khaton, S-I Khasiwagi, T. Iimori and N. Ohta, Appl. Phys. Lett. **93**, 234102 (2008)