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Photoinduced change in the electrical conductivity of polycrystalline silver iodide

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[Introduction] Silver iodide, a typical solid state ionic material, exhibits various phases and is well known as a superionic conductor having the phase transition temperature at 147 ^{0}C. Among the phases, thermodynamically stable hexagonal wurtzite type structure named as β-AgI and meta-stable face centered cubic structure designated as γ-AgI coexist with each other. Furthermore, the β-AgI transforms to γ-AgI by pressing or by grinding whereas γ-AgI transforms to β-AgI by aging or by heating involving interesting electrical properties [1]. In the present study, the photoinduced change in the electrical properties of polycrystalline AgI in its γ-AgI and β-AgI structures (ionic system) has been reported.

[Experimental] The pellets of β-AgI having the pale yellow color and the pellet of greenish yellow colored γ-AgI were prepared by using commercially available silver iodide powder. The samples were characterized by using X-ray diffraction powder method, and the electrical conductivity measurements were carried out by using complex impedance spectroscopy (ac method) and steady state photocurrent excitation spectroscopy (dc method) at room temperature.

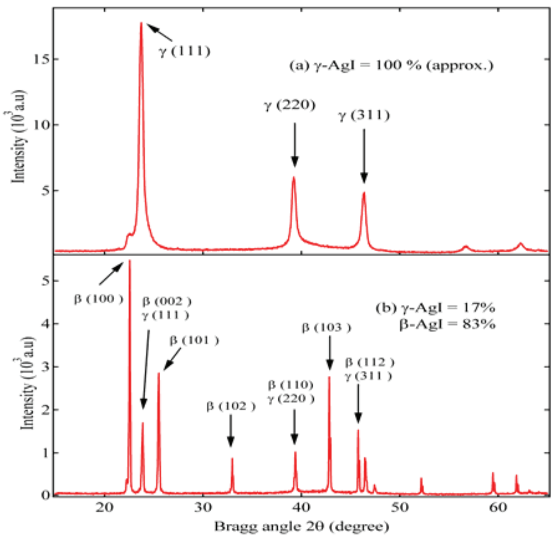

Fig 1: XRD pattern of γ-AgI (a) and β-AgI (b).

[Results and discussions] The X-ray diffraction patterns of prepared γ-AgI and β-AgI pellets are shown in Fig 1(a) and 1(b), respectively. The freshly prepared polycrystalline γ-AgI pellet contains almost 100 % γ-component whereas the pale yellow colored β-AgI pellet contains 83% β-structure and 17 % γ-structure. The broadening and disappearance of the diffraction band at (h0l) position in the XRD of γ-AgI pellet indicates the transformation of β-AgI to γ-

AgI. Fig 2(a) and 2(b) present the photoinduced change in the Cole-Cole plots of polycrystalline γ-AgI and β-AgI, respectively. A significant shift of the bulk resistance to the lower resistance state is clearly observed with the photoirradiation at 450 nm in the case of β-AgI. A small shift of the bulk resistance of γ-AgI is also obtained as shown in the inset of Fig

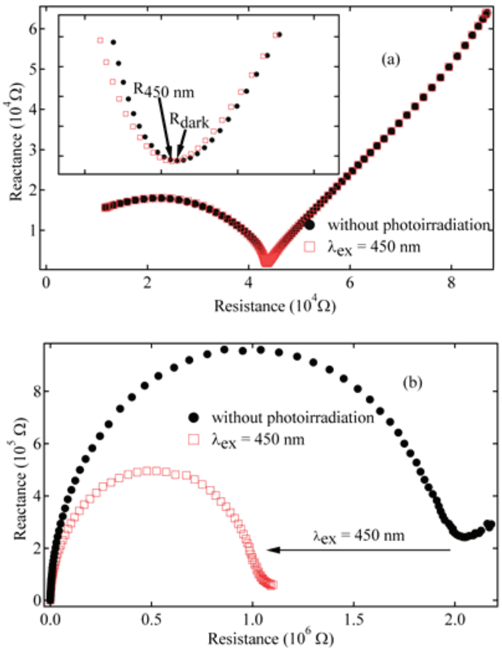

Fig 2: Cole-Cole plots of polycrystalline γ-AgI (a) and β-AgI (b) with (□) and without (●) photoirradiation at 450 nm measured by the ac method. The inset of (a) is the expansion of Cole-Cole plots in the bulk resistance region indicating the shift of the Cole-Cole plots with photoirradiation.

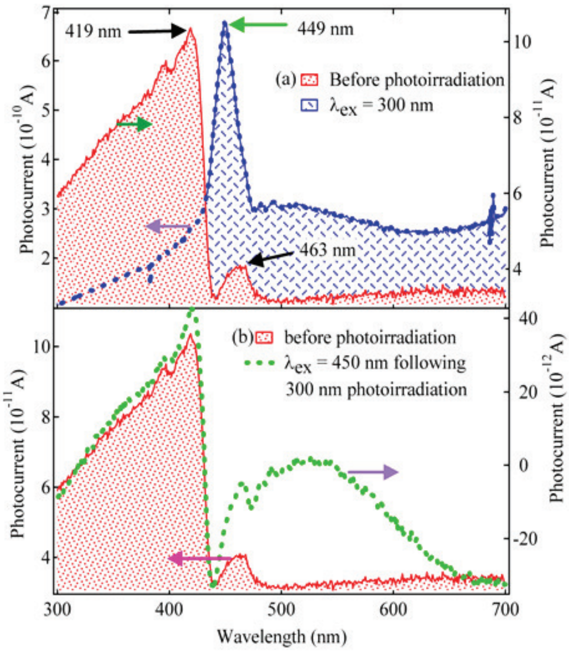

Fig 3: Photocurrent excitation spectrum of polycrystalline γ-AgI following the photoirradiation at 300 nm and at 450 nm indicating the red and blue shifts of the exciton band, respectively.

1(a). In Fig 3(a), the exciton band in the photocurrent excitation spectrum of γ-AgI is red shifted (30 nm) by the photoirradiation at 300 nm for 10 min and the red shifted exciton band is again blue shifted by the photoirradiation at 450 nm for 10 min as shown in Fig 3(b). Therefore, the reversible red and blue shifts of the exciton band in the photocurrent excitation spectrum of polycrystalline γ-AgI are obtained by alternate photoirradiation at 300 nm and at 450nm, respectively. The photoinduced enhancement of the electrical conductivity of polycrystalline AgI, the photocurrent excitation spectrum and its dependences on the excitation light intensity as well as on the excitation time will be discussed.

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