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Photoirradiation effects on the impedance spectra and the photocurrent spectra of silver iodide

Rahima Khaton[a,b], Toshifumi Iimori[a,b], Nobuhiro Ohta[a,b]

[a]Graduate School of Environmental Science, Hokkaido University, Japan

[b]Research Institute for Electronic Science, Hokkaido University, Japan

1. Introduction

Silver iodide is known as a typical superionic conductor that shows superionic phase transition at 147 °C. The superionic state (α-AgI) demonstrates highly disordered cation (Ag^+) distribution and rigid crystal framework fixed by the anion (I^-) where cation can moves through the framework, giving rise to the ionic conductivity as high as 1 $\Omega^{-1}cm^{-1}$[1]. The electrochemical behaviors, dielectric properties and temperature dependence of AgI have been extensively studied. However, the study of photoirradiation effects on polycrystalline β-AgI and α- AgI has been very limited so far. In this study, we measure the photoirradiation effects on impedance spectra and photocurrent spectra of polycrystalline AgI at room temperature. The impedance spectroscopy, which shows the relationship between the real and imaginary parts of the impedance as a function of frequency, is a powerful method to find out the dynamics of mobile charge carrier in the bulk and interfacial regions of any kind of solid or liquid materials [2]. It is expected to investigate the photoirradiation effects on ionic conductivity of polycrystalline AgI.

2. Experimental

The impedance spectra were measured with a pressed pellet of AgI as a function of frequency from 42 Hz to 5 MHz by using a computer controlled LCR meter. Colloidal silver and carbon pastes were used as electrodes. The photocurrent spectra were recorded with a help of KEITHLEY 617 programmable electrometer in the wavelength range from 700 nm to 300 nm.

3. Results and discussion

Fig.1 shows the impedance spectra of polycrystalline β-AgI without and with photo-irradiation at $\lambda = 450\,\mathrm{nm}$. The straight line in the high resistance region is a characteristic of a double layer capacitance at the electrode-electrolyte interface. The semicircle at the high frequency region is a characteristic of the bulk relaxation. The intercept of the straight line on the real axis (i.e. resistance axis) of the impedance spectra gives the bulk resistance. With photoirradiation, the size of the semicircle decreases and the bulk resistance shifts towards the origin; the conductivity increases. The photocurrent and the absorption spectra are shown in fig. 2. It is known that, due to the local elastic stress, the activation energy of the migration of silver cation is decreased with photoirradiation [3]. Therefore, in the low absorbance region, because of the long penetration depth of light, a large number of Ag^+ interstitials in the bulk, which causes higher photocurrent, are induced by the local elastic stress. In the high absorbance region, as the penetration depth of light is small, the local elastic stress on few Ag^+ interstitials in the surface generates low photocurrent. Moreover, the induced silver charge carrier in the surface can perform electrochemical reaction with oxygen and moisture of the air. Hence, the mobility of the charge carrier is decreased in the large absorbance region, and the photocurrent decreases. The enhancement of the ionic conductivity of the polycrystalline AgI, obtained from the impedance spectra, is about 14% with photoirradiation at wavelength 450 nm. Thus, the ionic conductivity of the polycrystalline AgI at room temperature can be induced by photoirradiation.

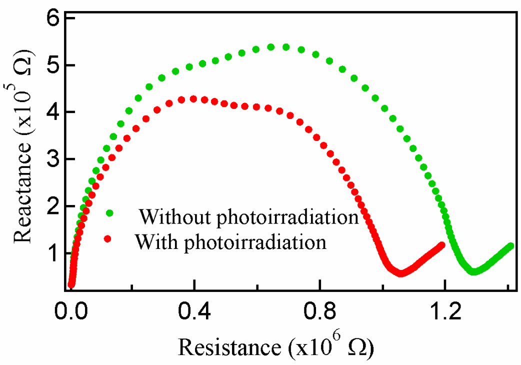

Fig. 1 The impedance spectra of AgI with and without photoirradiation at room temperature

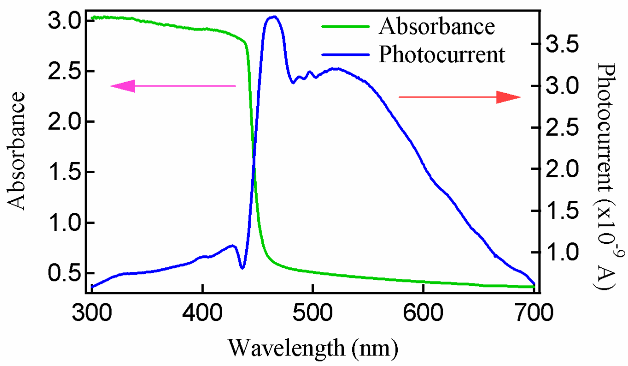

Fig. 2 The photocurrent spectrum and absorption spectrum of AgI at room temperature

References

1. H. Correa, R. A. Vargas, J. Garcia-Barriocanal, A. Rivera, J. Santamaria, C. Leon, *J. Euro. Cera. Soc.* **27,** 4297 (2007).

2. J. R. Macdonald, *Impedance spectroscopy: Emphasizing solid materials and systems*, John Wiley and Sons, New York, 1987.

3. S. Bredikhin, *Solid State Ionics*, **136-137,** 387 (2000).