（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。 ）

| TOKAI CROSS Experimental Report J-PARC | 提出日 Date of Report<br>2013/02/22 |
|---|---|
| 課題番号 Project No.<br>2012A0068<br>実験課題名 Title of experiment<br>In-situ neutron reflectivity measurements for photodoping of silver in Ge-chalcogenide films<br>実験責任者名 Name of principal investigator<br>Yoshifumi Sakaguchi<br>所属 Affiliation<br>CROSS | 装置責任者 Name of responsible person<br>Masayasu Takeda<br>装置名 Name of Instrument/(BL No.)<br>SHARAKU (BL 17)<br>実施日時 Date and time of Experiment<br>2012/05/05-05/07<br>2012/06/22-06/24<br>2012/11/08-11/12 |

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）

Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

$Ge_{40}S_{60}$ films

Ag/$Ge_{40}S_{60}$ films

Ag film

2. 実験方法及び結果 （実験がうまくいかなかった場合、その理由を記述してください。）

Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

Experimental method:

In order to clarify the change on the depth profile in Ag/amorphous (a-) Ge chalcogenide films by silver photo-doping, we have investigated on the neutron reflectivity of Ag/a-$Ge_{40}S_{60}$ films under a light illumination. In the experiment, we used a xenon lamp unit (MAX-303, ASAHI SPECTRA) as an excitation light source. The illumination area on the film was 20mm x 20mm. Neutron reflectivity measurements have been made on BL17 (SHARAKU) with unpolarized neutron beam mode. We measured neutron reflectivity of the sample before light illumination and after reaching the saturation of the silver photo-doping in the Q-region up to 0.08 $A^{-1}$. The light was exposed on the film for 90 minutes and neutron reflectivity measurements have also been made during the light illumination, fixing the angle of a detector.

Experimental results:

Fig.1 shows the neutron reflectivity of Ag 500 Å / a-$Ge_{40}S_{60}$ 1500Å / Si substrate (the thicknesses were given by a quartz crystal unit in a thermal evaporator) before making a light exposure. The dots show the experimental data while the solid curve shows the result of fitting. The inset table summarizes the thicknesses which were used in the fitting calculation. As shown in the table, the film is considered to maintain the two layer structure composed of Ag and a-$Ge_{40}S_{60}$, without making silver photo-doping.

2. 実験方法及び結果（つづき） Experimental method and results (continued)

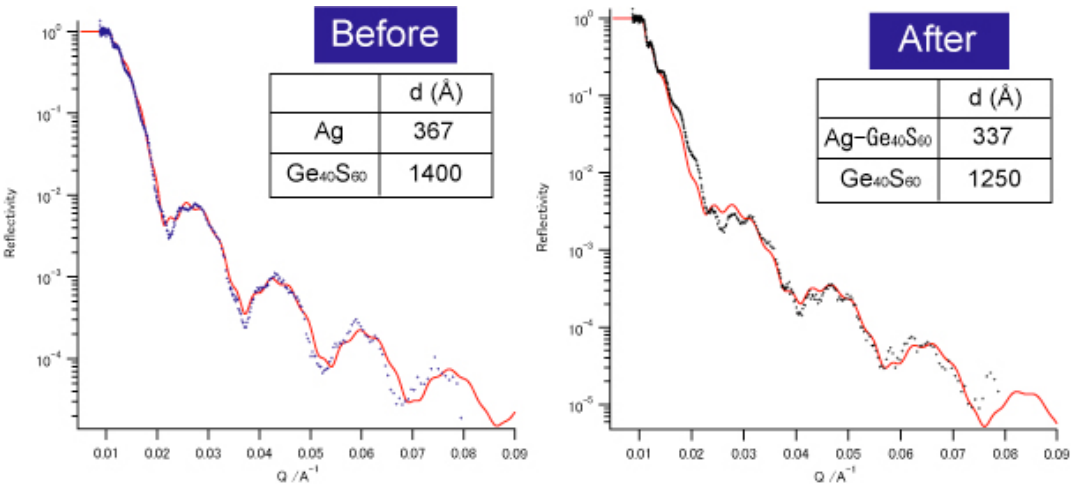


Fig.1 (Left) Neutron reflectivity of Ag 500 Å/a-$Ge_{40}S_{60}$ 1500Å /Si substrate film before making light illumination.
Fig.2 (Right) Neutron reflectivity of Ag 500 Å/a-$Ge_{40}S_{60}$ 1500Å / Si substrate film after reaching the saturation of silver photo-doping.

Fig.2 shows the neutron reflectivity of the film after reaching the saturation of silver photo-doping. As shown in the table, a pure silver layer has been disappeared while silver-doped $Ge_{40}S_{60}$ layer has been formed leaving non-silver-doped $Ge_{40}S_{60}$ layer (pure $Ge_{40}S_{60}$ layer) region. This result of fitting shows that silver photo-doping occurs forming one uniform silver-doped layer, which is distinguished from pure $Ge_{40}S_{60}$ layer. This is consistent with previous results of RBS, ESCA and optical measurements, showing that the silver diffusion front has a step-like concentration profile.

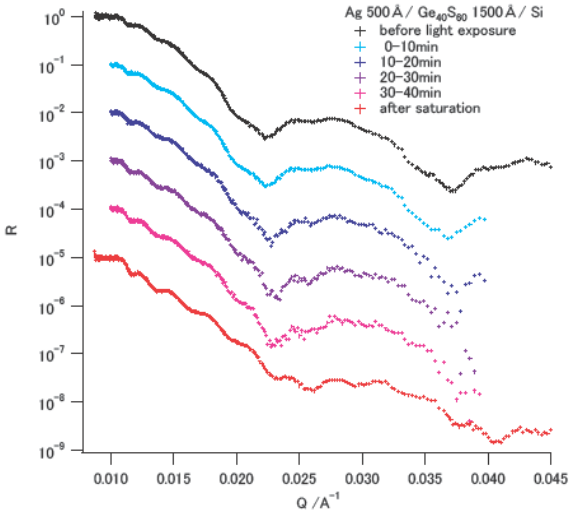


Fig. 3 Time evolution of neutron reflectivity during light illumination

The time evolution of neutron reflectivity during light illumination is plotted in Fig.3. As shown in the figure, we could observe the neutron reflectivity in the process of silver photo-doping from an initial state every 10 minute. Before making experiments, we have expected to have a clear change in the reflectivity profile, indicating a presence of three layers (Ag/ Ag photo-doped a-$Ge_{40}S_{60}$ / pure a-$Ge_{40}S_{60}$) and time evolution of their thicknesses. However, we have failed to fit modeled neutron reflectivity profiles to the experimental data, by assuming such three layers. Probably, the process of silver photo-doping cannot be described by the three layers model and we might need much consideration on the nature of Ag/ Ag photo-doped a-$Ge_{40}S_{60}$ interface. We are now trying to solve the problem by further analysis.