P 型酸化物半導体 $CoGa_2O_4$ 薄膜の作製と光電気化学特性

Fabrication of p-type $CoGa_2O_4$ thin film and its photoelectrochemical properties

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The photoelectrical properties of transition metal oxide have a lot of applications such as solar cells and water splitting by sunlight. So far, a number of studies have been done on the photoelectrochemical properties of n-type oxide semiconductors like Fe_2O_3 and TiO_2 for the application to the solar water splitting because their good stability in water and high responsiveness to visible light[1]. On the contrary, the photoelectrochemical properties of p-type semiconductor materials are not reported a lot because they are unstable and sensible to photocorrosion.[2]

In this study, we focused on a p-type semiconductor oxide $CoGa_2O_4$ (CGO). Thin films of CGO were fabricated using a pulsed laser deposition (PLD) technique. The substrate temperature and oxygen pressure during the deposition were maintained at 700°C and 0.1Pa, respectively. Single crystalline plates of STO·Nb (100) and $MgAl_2O_4$ (100) were employed as substrates for film growth. Figure 1 shows the XRD patterns of CGO films formed on two different substrates. The CGO films were found to grow epitaxially on STO and MAO substrates. As shown in the AFM image (inset of Fig. 1), CGO film has a very smooth surface with average roughness is 0.1815nm.

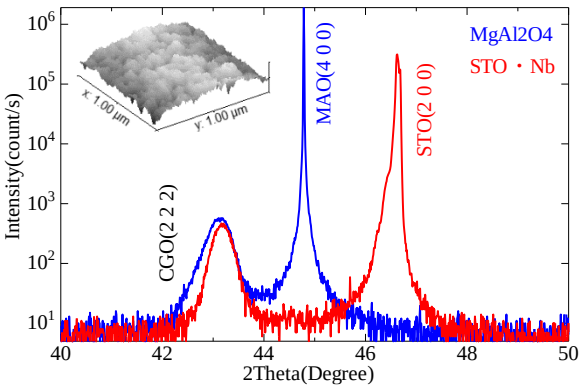

Figure 1 XRD pattern of CoGa2O4 thin film on STO·Nb(100) substrate(blue line) and MgAl2O4 spinel substrate(100) (red line). Insert image is 3D AFM image.

Figure 2 shows the I-V curve of $CoGa_2O_4$ thin film under light illumination of visible light (λ= 400-900nm) at the voltage range from 1 to -1V (V vs. Ag/AgCl). As shown in Fig.2, cathodic and anodic photocurrent were observed for $CoGa_2O_4$ have a typical p-type behavior when applied light. By calculate, we know the bandgap of CGO is about 2.5eV. The electrical, optical and photoelectric properties of CGO will be further discussed in terms of its electronic structure.

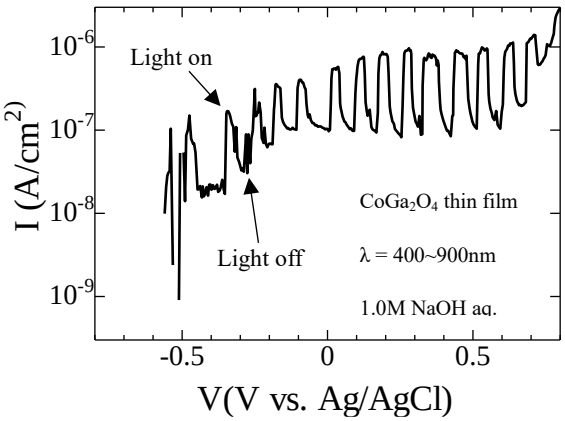

Figure 2 I-V of CoGa2O4 thin film.

Reference:

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