Conforcal-Microscopy Analysis of Photoluminescence on Silver-Indium-Disulfide Crystals

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Photoluminescence (PL) method is a very sensitive and useful tool to examine an electronic structure and defect-related properties of materials. Practically, we can observe in the microscopic region of the materials by using its confocal- microscope system.

On the other hand, the ternary semiconductor $AgInS_2$ of chalcopyrite family has much attention as a promising material for thin-film solar cell. However, the fundamental physical properties of the compound have not been well understood because it is difficult to grow large-size single crystals for the measurements.

In this work, we have investigated PL of $AgInS_2$ crystals at band-edge and deep level region by using a confocal microscope system. Samples for the measurements were bulk crystals of $AgInS_2$ grown by a hot-press method.

X-ray diffraction pattern of the samples indicates that they contain $AgInS_2$ crystals with chalcopyrite and orthorhombic structures and $AgIn_5S_8$ crystals with cubic structure. On the samples, we observed at 77K two dimensional image of PL intensity at 1.88 eV which corresponds to free-exciton energy of $AgInS_2$ with chalcopyrite structure, as shown in Fig. 1. We obtained detailed distribution of different PL intensity because the measurement system has a resolution of micro-meter order.

On white and black parts of the image, PL spectra clearly show free-exciton peaks with orthorhombic and chalcopyrite structures (Fig. 2(a) and (b)), respectively.[1)] We focus on the spectra with A-peak located at 1.88 eV and B-peak at 1.62 eV on chalcopyrite structure. The A-peak consists of free exciton and bi-exciton emission, while the B-peak is attributed to donor-acceptor pair transition.

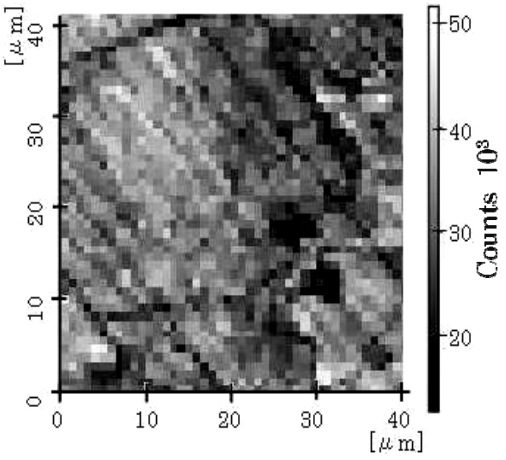

Fig. 1 Two dimensional image of PL intensity at 1.88 eV which corresponds to free-exciton energy of $AgInS_2$ with chalcopyrite structure.

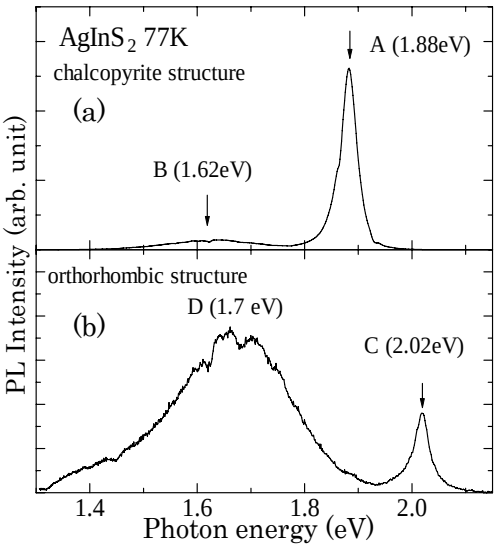

Fig. 2 Photoluminescence spectra with chalcopyrite and orthorhombic structure.

References

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