CuInSe\textsubscript{2}/CuGaSe\textsubscript{2} 単一量子井戸の時間分解フォトルミネッセンス測定

Time resolved photoluminescence measurement of CuInSe\textsubscript{2}/CuGaSe\textsubscript{2} single quantum well

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CuInSe\textsubscript{2} (CIS) and related materials are leading candidates for low cost, high efficiency absorber layers for solar cells.\textsuperscript{1} These materials can be also applied to variety of electro-optic devices.\textsuperscript{1} However, the carrier lifetime of CIS/CuGaSe\textsubscript{2} (CGS) QWs has not been investigated yet. In this study, we report the carrier lifetime of CIS/CGS single QW obtained by time-resolved photoluminescence (PL) measurement.

A 500 nm thick-CGS layer, a 7 nm thick-CIS well layer and a 500 nm thick-CGS layer was grown on GaAs (001) substrate by employing the deposition sequence of migration enhanced epitaxy using molecular beam epitaxy system.\textsuperscript{2} In this time-resolved PL measurement, a femtoseconds Ti:sapphire laser tuned to 760 nm was used as an optical source. After photo-excitation of the sample, PL was dispersed by the spectrometer and then detected by a streak camera with a time resolution of 15 ps.

Figure 1 shows the PL decay of the CIS/CGS QW when the excitation power is 30 mW at 10 K. The PL decay time is obtained to be 21.5 ps by a single exponential fitting. Figure 2 shows the temperature dependence of carrier lifetime. This result shows that the carrier lifetime increases as temperature increases. This behavior is similar to the case of III-V compound semiconductor QW such as GaInP/AlGaInP.\textsuperscript{3} However, the present carrier lifetime of CIS/CGS QW is one order of magnitude shorter than that of III-V QW. The carrier lifetime of CIS thin film with Cu rich (Cu/In > 1) composition is reported to be 33 ps at 8.5 K.\textsuperscript{1} The similarity of the short carrier lifetimes may indicate the contribution of non-radiative recombination.

Fig. 1 PL decay of CIS/CGS QW excited by 30 mW at 10 K. PL decay times evaluated by a single exponential fitting.

Fig. 2 The temperature dependence of carrier lifetime at 30 mW.

\textsuperscript{1} K. Puech et al., Appl. Phys. Lett. 69, 22 (1996).