Light absorption via discrete states in AlGaAs solar cell embedded with Er complex

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Here we report on the fabrication of a AlGaAs solar cell where discrete states were formed through the formation of Er complex. Er is particularly of interest because it has been reported that the transition in the 4*f* shells between the first excited state $^4I_{13/2}$ and ground state $^4I_{15/2}$ of Er^{3+} occurs at 1.54 μm (0.8 eV) [1].

All samples were grown by molecular beam epitaxy (MBE) on n-type GaAs (100) substrate, and Si and Be were used as n-type and p-type dopant, respectively. An Er doped $Al_{0.3}Ga_{0.7}As$ layer of 1 μm deposition thickness was fabricated at Er cell temperatures varied from 700℃ to 1100℃. For evaluation of photovoltaic characteristics, we fabricated p-i-n AlGaAs solar cell structure and Er was doped into the i-layer. As shown in PL spectrum in Figure 1, two emission peaks corresponding to the $^4I_{13/2}$ and ground state $^4I_{15/2}$ of Er^{3+} at 1.54 μm and 1.56 μm showed maximum value for Er cell temperature at 800℃. Figure 2 shows the external quantum efficiency results for the Er-doped solar cell under different reverse bias voltage. It can be clearly confirmed here that light absorption occurs at wavelength beyond 680 nm due to the light absorption via the discrete states from Er complex center. Figure 3 shows the comparison of the I-V curves measured for the samples with and without Er complex. Normal light response was confirmed for the sample embedded with Er complex at light wavelength of 780 nm.

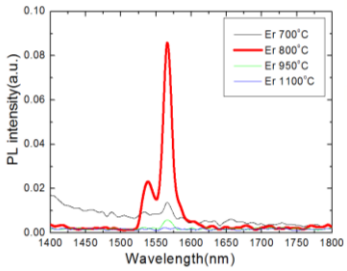

Fig. 1 PL spectra at 20 K for Er doped $Al_{0.3}Ga_{0.7}As$ film.

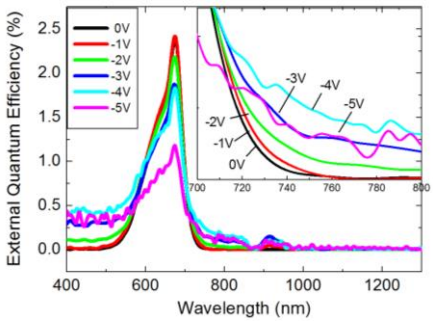

Fig. 2 EQE of the Er-doped solar cell with different reverse bias.

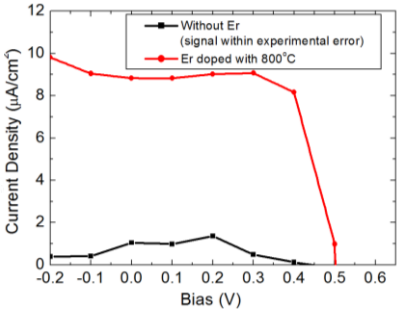

Fig. 3 I-V curves illuminated with LED at 780 nm.

Acknowledgements

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Reference

[1] Elsaesser, D.W. *et al.*, Journal of Crystal Growth 127, 707 (1993).