

Broadband emission in Er-Tm codoped ZnO film: Energy transfer from ZnO host to rare earth ions

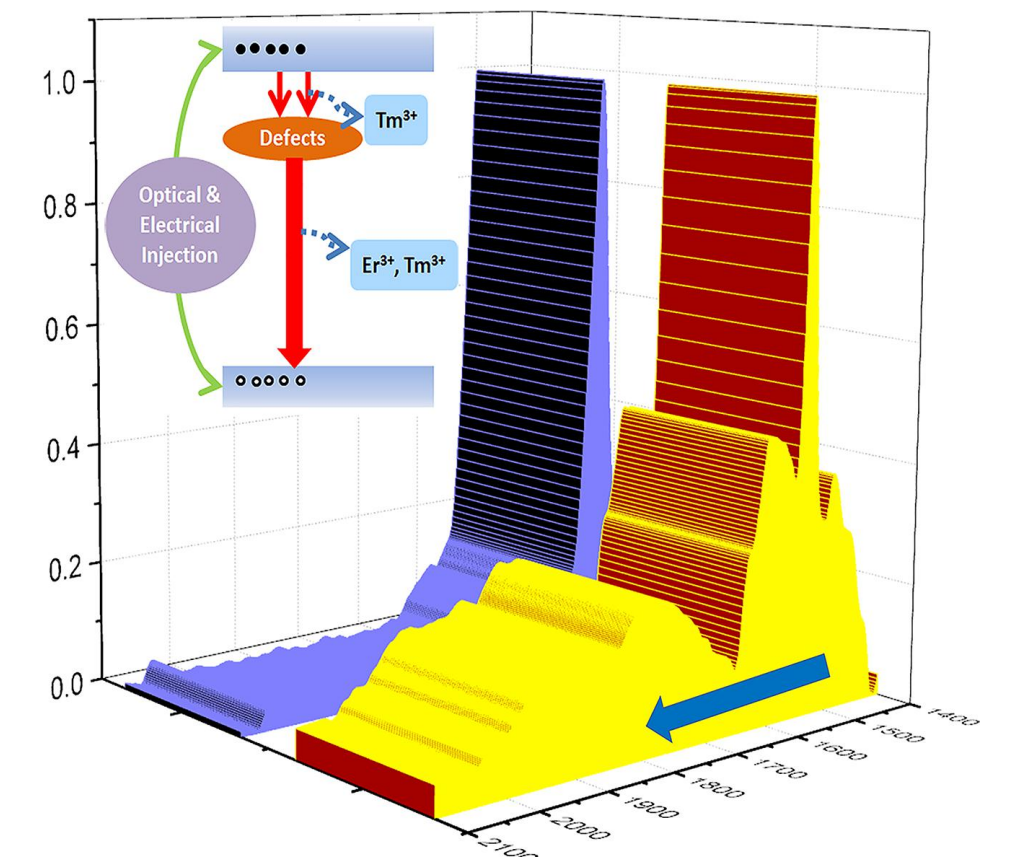
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Motivation

The increasing demand for information traffic requires the development of the wide band light sources and optical amplifiers urgently for full utilization of the 1400-1700 nm low-loss window band of silicon-based optical fibers. Overlapping emission bands from different rare earth (RE) ions can be used to provide a route to achieve such broadband emission. Infrared electroluminescence of the Er-Tm codoped semiconductor materials have never been studied.



Photoluminescence (PL)

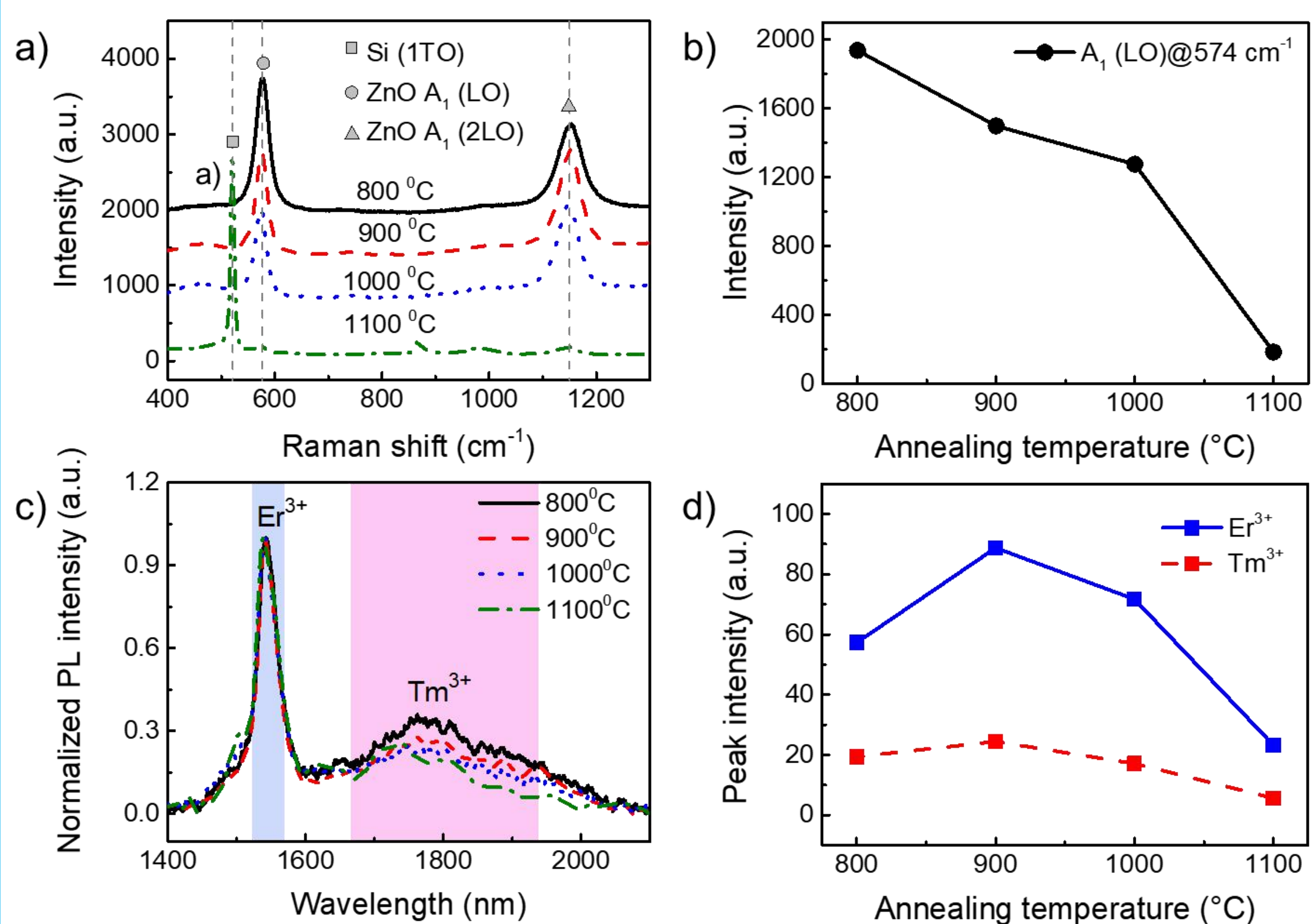


Figure 1 a) Raman spectra of the ETZO films. b) Annealing temperature dependence of the intensity of Raman peak at 574 cm^{-1} . c) RT PL spectra of the ETZO films each is normalized by the corresponding emission intensity of Er^{3+} : $^4\text{I}_{13/2} \rightarrow ^4\text{I}_{15/2}$. d) Annealing temperature dependencies of the intensity of the Er^{3+} and Tm^{3+} ions related emissions.

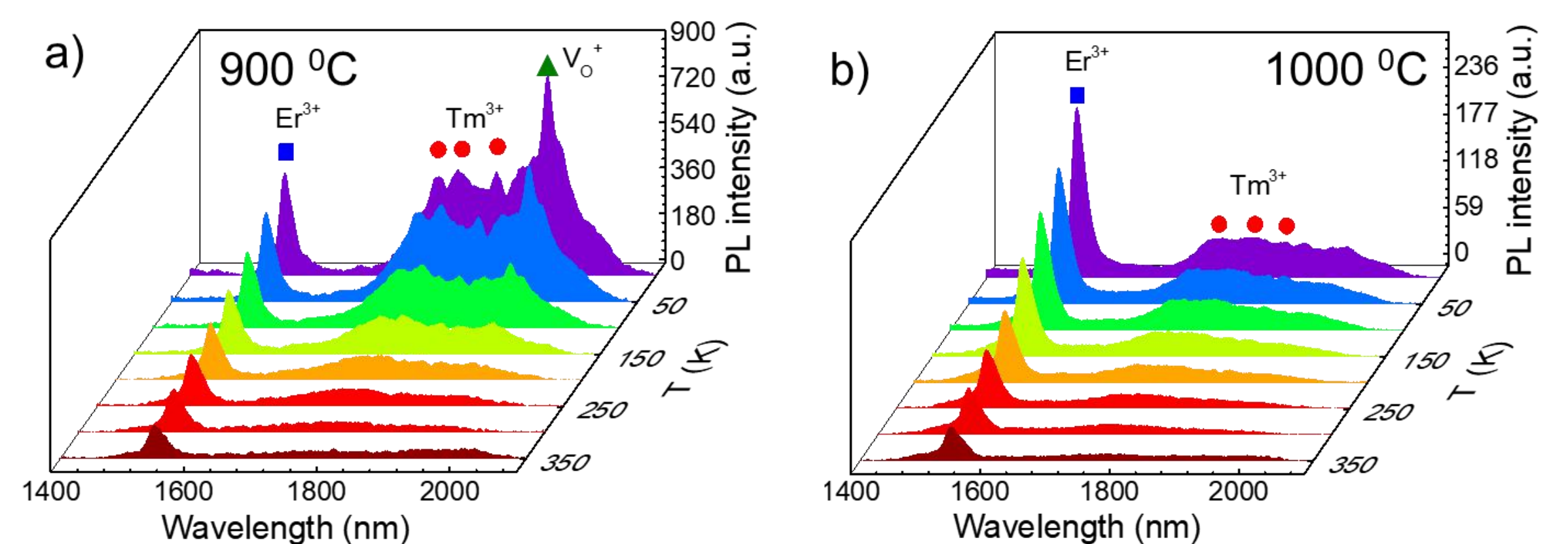


Figure 2 PL spectra of the ETZO films annealed at 900 a) and 1000 °C b) measured at different temperatures in the range of 10-350 K.

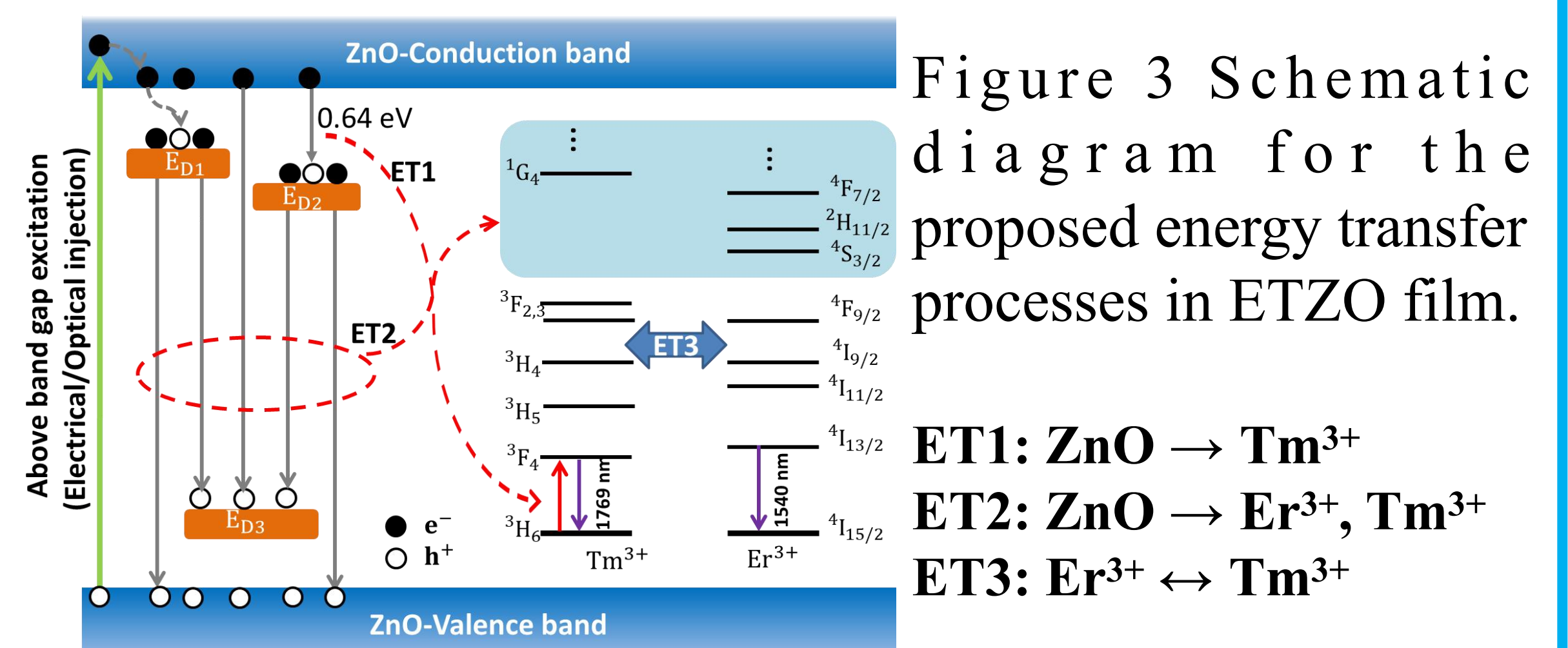


Figure 3 Schematic diagram for the proposed energy transfer processes in ETZO film.

Electroluminescence (EL)

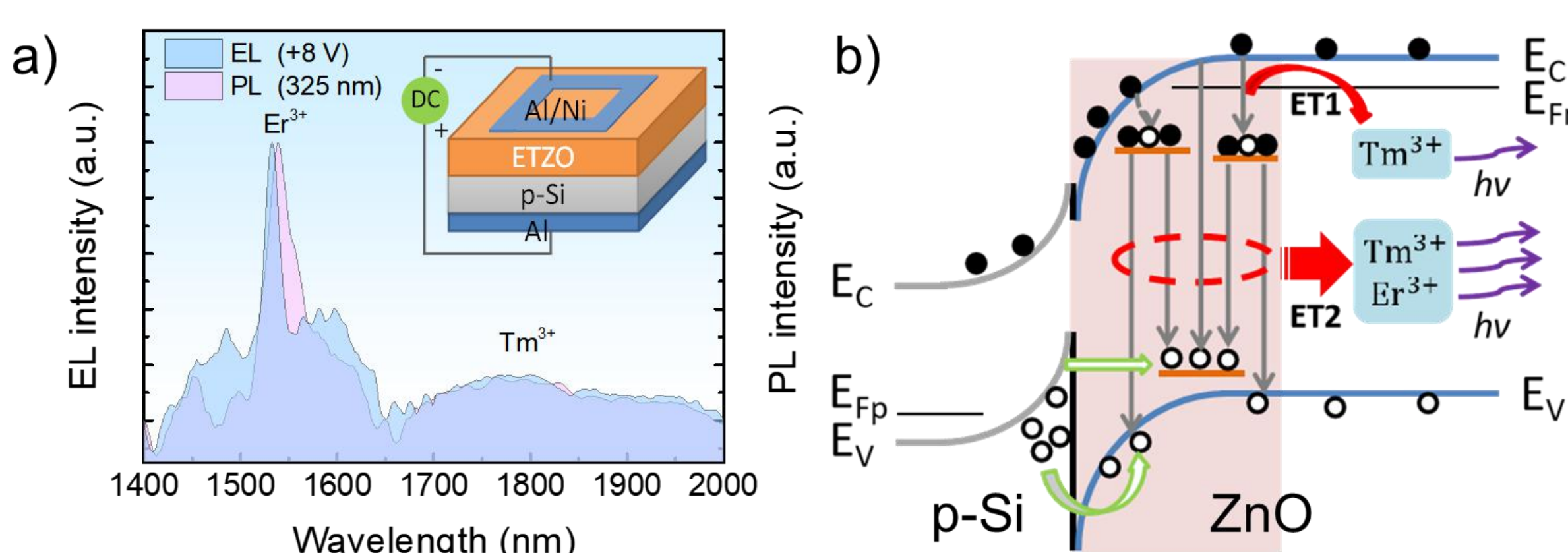


Figure 4 a) RT EL and PL spectrum of Al/Ni/ETZO/p-Si/Al device. b) Schematic diagram for the energy band structure of the ETZO/p-Si device under sufficiently high forward bias voltage.

Conclusion

- 1400-2100 nm broadband emission (PL and EL), attributed to the radiative transitions of Er^{3+} : $^4\text{I}_{13/2} \rightarrow ^4\text{I}_{15/2}$ and Tm^{3+} : $^3\text{F}_4 \rightarrow ^3\text{H}_6$ was successfully achieved.
- The defect states of ZnO act as channels for the energy transfer from ZnO to Er^{3+} and Tm^{3+} ions by the recombination of the defect states.
- These results pave the way for the practical application of ETZO films as the broadband infrared optical amplifiers and light emitters.