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Structural Characterization and Luminescence Properties of $Er_xSc_{2-x}Si_2O_7$ Prepared by RF Sputtering

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Er related luminescence at 1.53 µm from Er-doped materials has been under intense investigation [1–2] for its wide applications in optical telecommunications and Si photonics. However, the optical gains and luminescence efficiencies are limited by the low doping concentration of Er due to its low solid solubility in most host materials. A promising solution is to use Er-RE compounds (RE (Y, Yb, Tm) with same radii than Er), which permit to insert gradually Er ions inside a proper crystalline structure by substituting RE ions with Er ions. However, Er-RE silicate with RE radii (example: Sc (0.75Å) smaller than Er (0.881 Å) have not been enough investigated.

In this work, Er-Sc disilicate thin films were grown by RF-sputtering by alternating 15 nm thick layers of Er_2O_3, Sc_2O_3 separated by 15 nm SiO_2 layer, than deposited on 50 nm of Er_2O_3. These layers were deposited on SiO_2 (1.3 µm)/c-Si (100) substrate. After annealing at 1250 ^oC, Er and Sc diffuse in the SiO_2 layers with concentration of $6.7x10^{21}$ and $1.4x10^{21}$ at/cm^3, respectively. The synchrotron grazing incidence X-ray diffraction (GIXD) measurements coupled to selected area electron diffraction (SAED) analysis confirm the presence of $Er_xSc_{2-x}Si_2O_7$ compound. The dominant $Er_xSc_{2-x}Si_2O_7$ layer shows room-temperature photoluminescence peak at 1537 nm (Fig. 1 (a)). The shift peak emission compared to Y-Er silicate (where Y and Er have almost same ionic radii) is due to the small ionic radii of Sc^{3+} that enhanced the crystal field strength affecting the optical properties of Er^{3+} in Sc silicate phase. The effective excitation cross-section of Er in the formed compounds was equal to $\sigma_{ex} \approx 1.4x10^{-21}$ cm^2 for measured lifetime of 38 µs at λ_{ex} = 980 nm. The Er-Sc silicate opens a promise way to prepare photonic crystal light emitting devices.

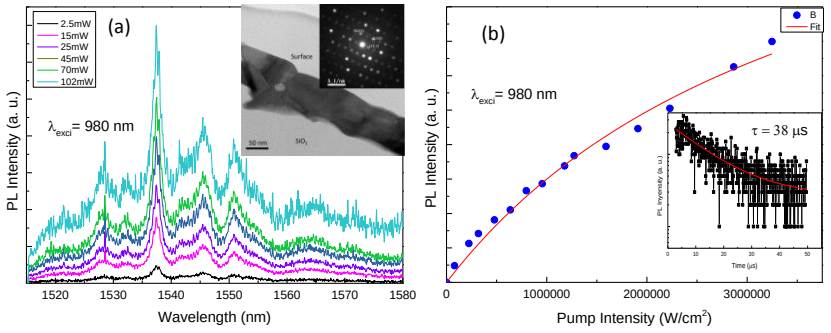

Fig. 1. (a) room temperature PL vs pump power for annealed sample at 1250 °C, inset cross-section TEM image after annealing with SAED image. (b) integrated PL intensity vs pump power, inset life time spectrum.

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