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Photoluminescence mechanisms of Tb^{3+} - doped porous GaP

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Abstract

Porous GaP (por-GaP) samples are doped with terbium ions (Tb3+) by simple impregnation followed by high-temperature annealing. From scanning electron microscopy (SEM) and energy dispersive X-ray (EDX) analysis, we show that the por-GaP skeleton is conserved and the Tb3+ ions are uniformly distributed in the host. The influence of annealing temperature on the luminescence intensity is explored. The photoluminescence (PL) intensity is found to be constant at temperatures lower than 130 K and quenches weakly for temperatures higher than 130 K. A quantitative model for excitation and de-excitation processes of Tb3+ in por-GaP based on the recombination of bound excitons to a Tb-related trap site is proposed that shows good agreement with experimental results. We show that the PL quenching above 130 K can be interpreted in terms of both a back transfer of Tb3+ excitation to the host and a weak thermalization of bound electrons to the conduction band.