# Enhanced light emission in active silicon-on-insulator photonic crystal slabs and slot waveguides

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The achievement of efficient light emission and extraction in Si-compatible systems is a fundamental issue for the development of a new class of optoelectronic devices. On one hand, among other approaches, the use of Er-doped silicon nanoclusters as an active material is promising because such structures show optical gain [1] and can be electrically pumped [2]. On the other hand, the use of periodically nanopatterned materials like photonic crystals (PhC) can greatly enhance radiation-matter interaction and drastically modify the emission properties of the active material.

In this work, we report on the realization and optical characterization of active silicon-on-insulator PhC waveguides which exhibit intense 1.54 μm emission at room temperature. The PhC slabs contain a thin layer of $SiO_2$ with $Er^{3+}$ doped silicon nanoclusters embedded at the center of the Si core and are patterned with a triangular lattice of holes. By tuning an appropriate mode of the PhC slab to the $Er^{3+}$ transition we observe an enhancement of the near-normal emission by more than two orders of magnitude with respect to the unpatterned slab [3]. The results are in good agreement with calculated photonic bands and emission spectra and are interpreted according to selection rules for allowed and forbidden radiative modes.

The role of the thin active layer, which acts as a field-confining slot waveguide, is further investigated by means of angle-resolved attenuated total reflectance and guided photoluminescence. It is shown that the electromagnetic field is strongly concentrated within the low-index slot layer for transverse-electric (TM) polarization, leading to a more than fivefold enhancement of guided emission for the TM mode over the TE one [4].

All these findings are important for the realization of Si-compatible efficient light emitters at telecom wavelengths.

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