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Room temperature reddish-yellow electroluminescence in manganese-doped silicon light-emitting diodes PHAM NAM HAI, Department of Physical Electronics, Tokyo Institute of Technology, DAIKI MARUO, LE DUC ANH, MASAAKI TANAKA, Department of Electrical Engineering and Information Systems, University of Tokyo — Silicon (Si) is an indirect band-gap semiconductor that does not efficiently emit light. Here, by utilizing optical transitions between the *p*-*d* hybridized orbitals of manganese (Mn) atoms doped in Si, we demonstrate Si-based light-emitting diodes (LEDs) that continuously emit reddish-yellow visible light at room temperature. The Mn *p*-*d* hybrid states are excited by hot holes that are accelerated in the depletion layers of reverse biased Si p-n junctions. Above a threshold reverse bias voltage of about -4 V, our LEDs show strong visible light emission with two peaks at $E_1 = 1.75$ eV and $E_2 = 2.30$ eV, corresponding to optical transitions from the t_-^{a} (spin-down anti-bonding) states to the e_- (spin-down non-bonding) states, and from the e_- to the t_+^{a} (spin-up anti-bonding) states as predicted by ab initio calculations. The internal quantum efficiency of the E_1 and E_2 transitions is 3 - 4 orders of magnitude higher than that of the indirect band-gap transition. We also demonstrate direct amplitude modulation of our LEDs at 1 Mbps. Our results open a way to utilize the 3d orbitals of transition metals in Si-based photonic devices.

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