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Synthesis and Luminescence of Silicon Remnants Formed by Truncated Glassmelt−Particle Reaction

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Abstract

We have obtained nanometer sized silicon remnants sequestered in glass matrices by terminating the reaction of pure silicon powders dispersed in the viscous melt at a temperature of 1400°C. Repeated use of this truncated melt−particle reaction process dilutes the amount and size of silicon remnants, and bulk samples containing nanosize silicon crystallites embedded in a glass matrix were eventually obtained. These quantum dot sized silicon−in−glass materials emit greenish luminescence with peak wavelengths from ≈480 to 530 nm, considerably shorter than the reddish luminescence (at about 700–850 nm) observed in porous silicon structures prepared by electrochemical etching techniques; upon complete digestion of Si particles by the melt, the luminescence peaks disappear. Since our silicon−in−glass preparation method does not involve etching, the origin of the luminescence is not likely to be due to Si−O−H compounds (e.g., siloxene) postulated recently. The location of the luminescence peaks and the observed silicon crystallite size suggest quantum confinement leading to a widened silicon band gap arising from remnants in the glass matrix smaller than the exciton diameter of bulk silicon (10 nm).