MAR06-2005-001098

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

**Light from Silicon-Based Nanostructures**

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Si-nanocrystals (Si-nc) embedded in $SiO_2$ glass matrices shows undoubtedly efficient room temperature light emission under optical pumping and sizable optical gain and light amplification have been demonstrated [1]. However, the presence of an insulating $SiO_2$ matrix prevents the fabrication of reliable and efficient electrically-driven devices and the efficiency of light emission is severely curtailed by the slow radiative lifetime of Si-nc. An alternative possibility is offered by the nucleation of Si-nc in dielectric hosts with smaller band-gaps. In this talk we will show our results on light-emitting Si-rich silicon nitride films (SRN) and photonic structures obtained by Plasma Enhanced Chemical Vapor Deposition (PE-CVD) followed by low temperature (500-900 $^\circ$C) thermal annealing[2]. The optical properties of SRNfilms are studied by micro-Raman and photoluminescence spectroscopy and demonstrate the presence of small Si-clusters with nanosecond recombination time and negligible emission thermal quenching. The electrical transport properties of SRN films are also investigated and efficient charge injection at low bias voltages is demonstrated. Additionally, we show that SRN matrices are suitable for efficient energy sensitization of Er ions emitting at 1.54 $\mu$m. The light emission mechanism in SRN nanostructures is studied by DFT-LDA *first principles* calculations showing that, largely Stokes-shifted, nanosecond-fast and efficient light emission in PE-CVD deposited SRN samples originates from strongly localized excitons transitions at the surface of small Si-nc ($\sim$ 1-2 nm) embedded in Silicon nitride[3]. Additionally, we show that the presence of bridging nitrogen groups at the surface of small Si nanocrystals can explain the origin of the experimentally measured Stokes-shift and the nanosecond relaxation times[3].

1. L. Pavesi, L. Dal Negro, C. Mazzoleni, G. Franzo, F. Priolo "*Optical gain in Si nanocrystals*", Nature 408, 440, 23 November 2000.

2. L. Dal Negro, J.H. Yi, V. Nguyen, Y. Yi, J. Michel, L.C. Kimerling, "*Spectrally enhanced light emission from aperiodic photonic structures*", Appl. Phys. Lett., **86**, 261905, (2005)

3. L. Dal Negro, J. H. Yi, L. C. Kimerling, S. Hamel, A. Williamson, G. Galli, *Light Emission from Silicon-rich Nitride Nanostructures,* Appl. Phys. Lett., submitted 2005