Abstract for an Invited Paper
for the NWS05 Meeting of
The American Physical Society

Optical Properties of Silicon Nanoclusters

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Silicon nanoparticles have been intensively investigated since the well-known 1990 report [1] on photoluminescence in porous silicon (this original reference in Applied Physics Letters now has over 3,500 citations!). Much of the current interest stems from the myriad applications for light emitting silicon in opto-electronics and photonics, but porous silicon tends to be mechanically and chemically fragile. One of the most exciting materials instead consists of well-passivated silicon nanocrystals embedded in a matrix of silicon dioxide – these nanocomposites emit a broad and relatively intense luminescence spectrum in the red to near infrared. When silicon nanocomposites are doped with erbium or other rare earth elements, the rare earth luminescence achieves some remarkable properties that are currently of significant technical interest. In this talk, I will briefly discuss the historical background of the work on light emitting silicon, the physics involved in the emission mechanism, the effects of doping silicon nanoclusters with rare earth ions, and the potential applications for these materials. Finally I will outline our own research group's progress in the last year toward extensive emission color control from silicon nanoclusters that can now be tuned throughout the visible spectrum and into the fiber transparency windows in the near infrared.
[1] L.T. Canham, Silicon quantum wire array fabrication by electrochemical and chemical dissolution of wafers, Appl. Phys. Lett. 57, 1046 (1990).