

Nanocomposites and nanomaterials

Comparative investigation of the formation of semiconductor nanocrystals in non-stoichiometric high-k materials

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During last decades the most attention was paid to the Si nanocrystals (Si-ncs) embedded in SiO₂. Bright visible emission at room temperature caused by recombination of excitons in Si-ncs was shown to be monitored via fine tuning of Si-ncs size distribution as well as precise control of oxide defects number. Obtained results and good compatibility of with existing CMOS technology forced an application of Si-nc-SiO₂ nanomaterials for microelectronics and photonics.

Despite of the widespread application of SiO₂ as a host for Si-ncs, its microelectronic and photovoltaic applications met some difficulty due low dielectric constant and/or high resistance. In this concern an application of other dielectrics became more attractive.

In present work, the composite films of “high-k” oxides (such as alumina and hafnia) doped with either Si or Ge were fabricated by RF magnetron sputtering and their structural, optical and luminescent properties were investigated versus deposition conditions and thermal treatment by means of Raman scattering, X-ray diffraction, high-resolution TEM and photoluminescence methods.

The results obtained for Si-ncs embedded in HfO₂ or Al₂O₃ will be discussed and compared with those of Si-ncs-SiO₂ systems. Besides, an attention will be paid to Ge-ncs embedded in high-k materials. The mechanisms of phase separation and formation of semiconductor nanoclusters/nanocrystals as well as light emitting mechanism will be discussed along with the perspectives for microelectronic application of such materials.