Nanotek-2013

OMICS Group Conferences
Accelerating Scientific Discovery

3rd International Conference on
Nanotek & Expo

December 2-4, 2013 Las Vegas, USA

Spatially controlled Si-V defect nanodiamonds with nitrogen-enhanced photoluminescence prepared by scanning probe lithography

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Abstract

Fluorescent nanodiamond offers a promising platform for many biological applications including imaging probes, drug delivery, and biosensing. This is due, in part, to the potential to incorporate photostable luminescent defect centers into nanoscale diamond crystals which are biologically compatible and easy to functionalize. We present the first demonstration of spatially controlled nanodiamonds with nitrogen-enhanced photoluminescence from silicon-vacancy (Si-V) defect centers incorporated during microwave-plasma chemical vapor deposition. The potential for further enhancement of Si-V emission from these nanodiamonds is demonstrated through controlled nitrogen doping by adding varying amounts of N_2 in a H_2 + CH_4feedgas mixture. At low levels, isolated substitutional nitrogen in {100} growth sectors is believed to act as a donor to increase the population of optically active $(Si\text{-}V)^-$ at the expense of optically inactive Si-V defects, thus increasing the observed luminescence from this center. The direct placement and manipulation of nanodiamonds is done by scanning probe lithography (SPL) using "inked" cantilevers. We explore suitable nanodiamond inks, the mechanism of ink transport, and parameters such as humidity and dwell time that affect the SPL process. The precise control in spatial arrangement of these highly photostable particles and their strong emission in the far-red (c.a. 738 nm) lends them well for applications in targeted drug delivery, biosensing and imaging devices as well as single cell *in vitro* studies for very specific therapeutic dosing or release kinetics.

Biography

Aaron Catledge received his PhD in Materials Science from The University of Alabama at Birmingham (UAB) in 1999, where he continued postdoctoral studies. His research career has focused primarily on nano-biotechnology as it applies to development of nanostructured diamond coatings for orthopaedic/dental implants, electrospun composite scaffolds for tissue regeneration, and nanodiamond fluorescence in biosensing. Hismore than 55 peer-reviewed publications in the period from 2003-2013, which includes 3 book chapters as 1st author.