J Nanomed Nanotechnol 2016, 7:5 (Suppl)
http://dx.doi.org/10.4172/2157-7439.C1.044

Black diamond: A surface-nanostructured material for high temperature solar cells

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Black diamond is obtained by a controlled nanoscale periodic texturing of CVD diamond surface performed by means of ultra-short pulse laser. Such a process represents a technologically easy process to fabricate ripples with a periodicity of about 170 nm on diamond surface, able to drastically modify the interaction with solar radiation from typical optical transparency up to solar absorptance values even higher than 90%. Here we demonstrate that surface texturing gives rise to a strong enhancement of photo-responsivity in the visible range (up to two orders of magnitude larger than the starting transparent diamond film). The operating mechanisms of black diamond is discussed and explained by disentangling the optical enhancement from an electronic increased density of states within the diamond bandgap corresponding to an actual intermediate band able to support an efficient photoelectronic conversion of sub-bandgap photons (<5.47 eV). The introduction of an intermediate band results in an enhanced external quantum efficiency up to 800 nm wavelengths, without affecting the film transport capabilities. Here, we further discuss recent results of process development and optimization, such as a reduced periodicity of the ripples and fabrication of 2D periodic structures. The achieved optical and photoelectronic outstanding results open the path for future application of black diamond as a photon-enhanced thermionic emission cathode for solar concentrating systems, with advantages owing to the excellent electronic properties combined with a potentially very low work function and high thermal stability.

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Building supramolecular peptide nanostructures by exploiting aromatic and helix-helix macrodipole interactions

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Biomolecules have been extensively investigated as possible components of nanoscaled electronic circuits. In particular, hybrid materials obtained by functionalizing metals with biomolecules have been recently synthesized, paving the way for the fast-growing field of bionanoelectronics. In this work mono- and bi-component peptide-based self-assembled monolayers (SAMs) have been immobilized on gold surfaces and studied by electrochemical and spectroscopic techniques. The peptides investigated comprised almost exclusively Cα-tetrasubstituted α-amino acids. These non-coded residues, because of their unique conformational properties, forced the peptide backbone to attain helical conformations, which promote the formation of stable SAMs on gold surfaces. Blocking experiments performed in potassium ferricyanide solution gave basic information on the stability and packing density of the peptide layers on the electro active surface, while fluorescence experiments performed by using spatially sensitive fluorescent probes, gave information about the possible formation, in the bicomponent SAMs, of raft domains, i.e. segregated single-component regions. The photocurrent generation properties of these mono- and bi-component peptide-based SAMs were studied by electrochemical and spectroscopic techniques. In fact, all the SAMs investigated were composed of peptides derivatized with chromophores strongly absorbing in the UV region to enhance the efficiency of the photocurrent generation. The composition of the bi-component SAMs on the surface have been analyzed by a combination of electrochemical and spectroscopic techniques. Interestingly, the surface composition is quite different from the solution stoichiometry used for SAM preparation.

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