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Functionalization of diatom nanostructures for device applications

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Many microorganisms have a unique capacity to create nanostructures with a hierarchical order and complexity that exceeds the capabilities of current nanotechnology. Our laboratory has been harnessing the biomineralization capacity of single-celled algae called diatoms to make nanopatterned metal oxide semiconductor materials that possess unique optical and electronic properties. A cell culture process is used to metabolically insert nanoscale titanium (Ti) or germanium (Ge) oxides into the photonic crystal-like structure of the diatom biosilica. The metabolic doping of Ge-oxide rich nanophases into the diatom biosilica, followed by thermal annealing in air between 250-450°C to activate the Ge-oxide luminescent centers, rendered the diatom biosilica highly photoluminescent, with emission centered at blue wavelengths. The incorporation of biogenic Ti-oxide nanophases into the periodic structure of the diatom biosilica, followed by thermal annealing in air to activate the amorphous Ti-oxide to the semiconducting anatase TiO2 form, served as a photocatalyst for decomposition of chlorinated organic compounds, and as a light trapping layer for enhancing the performance of dye-sensitized solar cell photoanodes. Antibody-functionalized diatom biosilica enabled the label-free detection of biomolecules, where selective antibody-antigen binding was registered through enhanced photoluminescence. These three examples illustrate how materials made through biological processes can be used to fabricate intricate nanostructured metal oxide materials with optoelectronic properties leading to interesting applications.

Biography

Greg Rorrer is currently Professor and Head of the School of Chemical, Biological, and Environmental Engineering at Oregon State University. Dr. Rorrer has a BS degree in Chemical Engineering from the University of Michigan, and a PhD degree in Chemical Engineering from Michigan State University. From 2009 to 2011, Dr. Rorrer served as the program director of the Energy for Sustainability program at the National Science Foundation. His research focuses on harnessing the unique biosynthetic capacities of photosynthetic algae for applications in nanotechnology, bioenergy, bioactive compound production, and environmental remediation.

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