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Optical transmission, scattering and luminescence properties of metabolically manipulated diatom frustules

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Diatoms are unicellular, microscopic, eukaryotic, photosynthetic algae that are found in both fresh water and marine environment and also in moist habitats. There are over 200000 species of these type of photosynthetic algae with world wide distribution and are responsible for 20-25% of global oxygen production by photosynthesis process. The morphogenesis of the peculiar cell wall (called frustule) architecture of diatom involves biomineralization of silica forming an array of patterns that ranges from submicrometric to nanometric scales. Such diatom frustules with their nanoporous structures exhibit peculiar optical properties which can be further enhanced by metabolic insertion of germanium (Ge), titania (TiO_2), *etc*. Notably, it is very important to know the way in which the diatom frustules and their nano-patterned structures interact with light for understanding the still unexplained extraordinary photosynthesis ability of diatoms.

In this work, fresh water diatoms were grown in the Tissue-Culture laboratory using alternate sources of silicon (Ge, As, *etc*). A cleaning procedure [1] was adopted to remove the external organic matrix covering the frustules. The morphology and elemental composition of the diatom frustules were analyzed respectively by scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS). The transmission and scattering measurements were conducted at 543 nm, 594 nm and 632 nm incident laser wavelengths by using an indigenously designed scatterrometer. The transmission and scattering properties of pure and metabolically manipulated diatom frustules were compared and analyzed. Photoluminescence measurements of frustules were performed at room temperature and at different excitation wavelengths. It was observed that the frustules emitted strong blue photoluminescence having a broad peak at around 425 nm when the samples were excited at UV wavelengths. Enhanced PL activity was observed in case of metabolically manipulated diatom frustules. However it was observed that at other excitation wavelengths in the visible region, diatoms do not show any luminescent activity. The results may be useful for potential applications in novel photonic and optoelectronic devices.

Reference

1. Gogoi, A., et al. *JQSRT* 110, 1566–1578, 2009.