Self-Cleaning Coatings and Materials for Decontaminating Field-Deployable Land and Water-Based Optical Systems

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This technology exploits the organic decomposition capability and hydrophilic properties of the photocatalytic material titanium dioxide (TiO_2), a non-toxic and non-hazardous substance, to address contamination and biofouling issues in field-deployed optical sensor systems. Specifically, this technology incorporates TiO_2 coatings and materials applied to, or integrated as a part of, the optical surfaces of sensors and calibration sources, including lenses, windows, and mirrors that are used in remote, unattended, ground-based (land or maritime) optical sensor systems.

Current methods used to address contamination or biofouling of these optical surfaces in deployed systems are costly, toxic, labor intensive, and non-preventative. By implementing this novel technology, many of these negative aspects can be reduced. The functionality of this innovative self-cleaning solution to address the problem of contamination or biofouling depends on the availability of a sufficient light source with the appropriate spectral properties, which can be attained naturally via sunlight or supplemented using artificial illumination such as UV LEDs (light emitting diodes).

In land-based or above-water systems, the TiO_2 optical surface is exposed to sunlight, which catalyzes the photocatalytic reaction, facilitating both the decomposition of inorganic and organic compounds, and the activation of superhydrophilic properties. Since underwater optical surfaces are submerged and have limited sunlight exposure, supplementary UV light sources would be required to activate the TiO_2 on these optical surfaces. Nighttime operation of land-based or above-water systems would require this addition as well. For most superhydrophilic self-cleaning purposes, a rainwater wash will suffice; however, for some applications an attached rainwater collector/dispenser or other fresh water dispensing system may be required to wash the optical surface and initiate the removal of contaminates. Deployment of this non-toxic,non-hazardoustechnology will take advantage of environmental elements (i.e. rain and sunlight), increase the longevity of unattended optical systems, increase the amount of time between required maintenance, and improve the long-term accuracy of sensor measurements.

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Separation of Single-Walled Carbon Nanotubes with DEP-FFF

Simultaneous type and diameter separation of SWNTs is achieved by using flow injection dielectrophoresis.

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A process using a modified dielectrophoresis device separates single-walled carbon nanotubes (SWNTs) according to their polarizability in electric fields. This depends on the size and dielectric constant of individual nanotubes and easily separates metallic from semiconducting nanotubes. Separation by length has also been demonstrated. Partial separation (enrichment) according to bandgap (which is linked to polarizability) has also been shown and can be improved to full separation of individual types of semiconducting SWNTs with better control over operational parameters and the length of SWNT starting material. This process and device can be scaled affordably to generate useful amounts of semiconducting SWNTs for electronic device development and production.

In this study, a flow injection dielectrophoresis technique was used with a modified dielectrophoresis device. The length, width, and height of the modified chamber were 28, 2.5, and 0.025 cm, respectively. On the bottom of the chamber, there are two arrays of 50-μm-wide, 2-μm-thick gold electrodes, which are connected to an AC voltage generator and are alternately arranged so that every electrode is adjacent to two electrodes of the opposite polar. There is an additional plate electrode on the top of the chamber that is negatively biased.

During the experiment, a syringe pump constantly pumps in the mobile phase, 1-percent sodium dodecylbenzene sulfonate (SDBS) solution, into the chamber. The frequency and voltage are set to 1 MHz and 10 V peak-to-peak, respectively. About 150 μL of SWNTs in 1-percent SDBS decanted solution are injected to the mobile phase through a septum near the entrance of the chamber. The flow rate of the mobile phase is set to 0.02 cm^3/min. The injected SWNTs sample flows through the chamber before it is lead into a fluorescence flow-through cell and collected for further analysis. The flow-through cell has three windows, thus allowing the fluorometer to collect fluorescence spectrum and visible absorption spectrums simultaneously.

Dielectrophoresis field-flow fractionation (DEP-FFF) generally depends on interaction of a sedimentation force and DEP force for particle separation, and SWNTs are neutrally buoyant in water. In this innovation, the third electrode was added to create a sedi-