Materials

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

Stennis Space Center, Mississippi

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.

This work was done by Robert Ryan, Lauren Underwood, and Kara Holekamp of Science Systems and Applications, Inc., George May of Institute of Technology Development, and Bruce Spiering and Bruce Davis of Stennis Space Center. For more information contact Robert Ryan at (228) 688-2276. Refer to SSC-00303.

Separation of Single-Walled Carbon Nanotubes with DEP-FFF

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

Lyndon B. Johnson Space Center, Houston, Texas

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 sedimentation force based on DC electrophoresis. This makes this particular device applicable to separations on any neutrally buoyant particles in solution and a more general process for a broad range of nanomaterials sorting and separations.

This work was done by Howard K. Schmidt, Haiqing Peng, Noe Alvarez, Manuel Mendes, and Matteo Pasquali of Rice University for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to MSC-24368-1/70-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Li Anode Technology for Improved Performance

John H. Glenn Research Center, Cleveland, Ohio

A novel, low-cost approach to stabilization of Li metal anodes for high-performance rechargeable batteries was developed. Electrolyte additives are selected and used in Li cell electrolyte systems, promoting formation of a protective coating on Li metal anodes for improved cycle and safety performance. Li batteries developed from the new system will show significantly improved battery performance characteristics, including energy/power density, cycle/calendar life, cost, and safety.

This work was done by Tuqiang Chen of TH Chem for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18715-1.