Physical Sciences

Method for Measuring the Volume-Scattering Function of Water

Goddard Space Flight Center, Greenbelt, Maryland

The volume scattering function (VSF) of seawater affects visibility, remote sensing properties, in-water light propagation, lidar performance, and the like. Currently, it's possible to measure only small forward angles of VSF, or to use cumbersome, large, and non-autonomous systems. This innovation is a method of measuring the full range of VSF using a portable instrument.

A single rapid-sensing photosensor is used to scan a green laser beam, which delivers the desired measurement. By using a single sensor, inter-calibration is avoided. A compact design is achieved by using drift-free detector electronics, fiber optics, and a new type of photomultiplier. This provides a high angular resolution of 1° or better, as well as the ability to focus in on a VSF region of particular interest.

Currently, the total scattering of light is measured as a difference from the other two parts of the light budget equation. This innovation will allow the direct calculation of the total scattering of light by taking an integral of the VSF over all angles. This directly provides one of the three components of the light budget equation, allowing greater versatility in its calculation.

This work was done by Yogesh C. Agrawal of Sequoia Scientific, Inc. for Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15395-1

Method of Heating a Foam-Based Catalyst Bed

John H. Glenn Research Center, Cleveland, Ohio

A method of heating a foam-based catalyst bed has been developed using silicon carbide as the catalyst support due to its readily accessible, high surface area that is oxidation-resistant and is electrically conductive. The foam support may be resistively heated by passing an electric current through it. This allows the catalyst bed to be heated directly, requiring less power to reach the desired temperature more quickly. Designed for heterogeneous catalysis, the method can be used by the petrochemical, chemical processing, and power-generating industries, as well as automotive catalytic converters.

Catalyst beds must be heated to a light-off temperature before they catalyze the desired reactions. This typically is done by heating the assembly that contains the catalyst bed, which results in much of the power being wasted and/or lost to the surrounding environment. The catalyst bed is heated indirectly, thus requiring excessive power. With the electrically heated catalyst bed, virtually all of the power is used to heat the support, and only a small fraction is lost to the surroundings.

Although the light-off temperature of most catalysts is only a few hundred degrees Celsius, the electrically heated foam is able to achieve temperatures of 1,200 °C. Lower temperatures are achievable by supplying less electrical power to the foam. Furthermore, because of the foam's open-cell structure, the catalyst can be applied either directly to the foam ligaments or in the form of a catalyst-containing washcoat. This innovation would be very useful for heterogeneous catalysis where elevated temperatures are needed to drive the reaction.

This work was done by Arthur J. Fortini, Brian E. Williams, and Shawn R. McNeal of Ultramet for John Glenn Research Center.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18155-1.

Small Deflection Energy Analyzer for Energy and Angular Distributions

NASA's Goddard Space Flight Center, Greenbelt, Maryland

The development of the Small Deflection Energy Analyzer (SDEA) charged-particle spectrometer for energy and angle distributions responds to a long-standing need to measure the wind velocity vector in Earth's thermosphere, and to obtain the ion-drift vector in the ionosphere. The air and ions above 120 km are endowed with bulk velocities and temperatures just like air near the ground, but with separate spatial and temporal variations. It is important to understand these not only for study of the physics and chemistry of the Sun-Earth connection, but also for spacecraft orbit predictions, and communications through the ionosphere.

The SDEA consists of a pair of parallel conducting plates separated by a small distance, with an entrance slit on one end, and an exit slit on the other. A voltage applied to these plates develops an electric field between the plates, and this field deflects ions passing through it. If an ion has too little energy, it will strike one of the plates. If it has too much, it will strike the back wall. An ion with the amount of energy being searched for will have its trajectory bent just enough to exit the back slit.

The SDEA units are compact, rectangular, and operate with low voltages. The units can be built up into small arrays. These arrays could be used either to widen the field of view or to sharpen an existing one. This approach can also be used to obtain angular distributions in two planes simultaneously, thus cutting down the ion source power requirements in half. This geometry has enabled a new mass-spectrometer concept that can provide miniaturized mass spectrometers for use in industrial plants, air-pollution monitoring, and noxious-gas detection.

This work was done by Federico A. Herrero of Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15610-1

Polymeric Bladder for Storing Liquid Oxygen

Lyndon B. Johnson Space Center, Houston, Texas

A proposed system for storing oxygen in liquid form and dispensing it in gaseous form is based on (1) initial subcooling of the liquid oxygen; (2) containing the liquid oxygen in a flexible vessel; (3) applying a gas spring to the flexible vessel to keep the oxygen compressed above the saturation pressure and, thus, in the liquid state; and (4) using heat leakage into the system for vaporizing the oxygen to be dispensed. In a typical prior system based on these principles, the flexible vessel is a metal bellows housed in a rigid tank, and the gas spring consists of pressurized helium in the tank volume surrounding the bellows. Unfortunately, the welds in the bellows corrugations are subject to fatigue, and, because bellows have large ullage, a correspondingly large fraction of the oxygen content cannot be expelled.

In the proposed system, the flexible vessel would be a bladder made of a liquid-crystal polymer (LCP). (LCPs are strong and compatible with liquid oxygen.) In comparison with a metal bellows, a polymeric bladder would have less ullage and would weigh less. In experiments involving fatigue cycling at liquid-nitrogen temperatures, two LCPs were found to be suitable for this application.

This work was done by David H. Walker, Andrew C. Harvey, and William Leary of Foster-Miller, Inc. for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-22943-1

Pyrotechnic Simulator/Stray-Voltage Detector

John F. Kennedy Space Center, Florida

The concept for a dual test item has been developed for use in simulating live initiators/detonators during ground testing to verify the proper operation of the safing and firing circuitry for ground and flight systems ordnance as well as continuous monitoring for any stray voltages. Previous ordnance simulators have consisted of fuses, flash bulbs, inert devices with bridge wires, and actual live ordnance items mounted in test chambers. Stray voltage detectors have included devices connected to the firing circuits for continuous monitoring and a final no-voltage test just prior to ordnance connection. The purpose of this combined ordnance simulation and stray-voltage detection is to provide an improved and comprehensive method to ensure the ordnance circuitry is verified safe and operational.

This work was done by Terry Greenfield of ASRC Aerospace Corp. for Kennedy Space Center. For further information, contact the Kennedy Innovative Partnerships Program Office at (321) 861-7158. KSC-13282

Inventions Utilizing Microfluidics and Colloidal Particles

Lyndon B. Johnson Space Center, Houston, Texas

Several related inventions pertain to families of devices that utilize microfluidics and/or colloidal particles to obtain useful physical effects. The families of devices can be summarized as follows:

- Microfluidic pumps and/or valves wherein colloidal-size particles driven by electrical, magnetic, or optical fields serve as the principal moving parts that propel and/or direct the affected flows.
- Devices that are similar to the aforementioned pumps and/or valves except that they are used to manipulate light instead of fluids. The colloidal particles in these devices are substantially constrained to move in a plane and are driven to spatially order them into arrays that function, variously, as waveguides, filters, or switches for optical signals.
- Devices wherein the ultra-laminar nature of microfluidic flows is exploited to effect separation, sorting, or filtering of colloidal particles or biological cells in suspension.
- Devices wherein a combination of confinement and applied electrical and/or optical fields forces the colloidal particles to become arranged into three-dimensional crystal lattices. Control of the colloidal crystalline structures could be exploited to control diffraction of light.
- Microfluidic devices, incorporating fluid waveguides, wherein switching of flows among different paths would be accompanied by switching of optical signals.