troscopy. The surface localized field enhancement could be used to probe the upper layers of a sample surface.

WGM resonances (1, 2, X =also termed morphology-dependent resonances) take place when an incident light becomes trapped near the inner surface of a particle resulting from total internal reflection. This results in enhancement of the evanescent electromagnetic field at certain nodes near the surface of the particle. WGM resonance structures have been proposed as chemical sensors and when coupled with conventional Plasmon-based SERS, for single-molecule spectroscopy.

Very large enhancements are feasible by using 5-micron silica microspheres. Enhancement factors comparable to those seen from noble metal spheroids are possible enhancements when the Raman-scattered radiation also overlaps with a WGM resonance. For microspheres with radius of 5 microns, the enhancement factor can exceed an order of magnitude. This is a significant result that indicates that it would be possible to observe SERS with nonresonant scatterers.

This work was done by Mark S. Anderson of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office–JPL. Refer to NPO-47604.t

3D Hail Size Distribution Interpolation/Extrapolation Algorithm

Multiple sensors are not required.

John F. Kennedy Space Center, Florida

Radar data can usually detect hail; however, it is difficult for present day radar to accurately discriminate between hail and rain. Local ground-based hail sensors are much better at detecting hail against a rain background, and when incorporated with radar data, provide a much better local picture of a severe rain or hail event.

The previous disdrometer interpolation/extrapolation algorithm described a method to interpolate horizontally between multiple ground sensors (a minimum of three) and extrapolate vertically. This work is a modification to that approach that generates a purely extrapolated 3D spatial distribution when using a single sensor.

A 3D high-resolution mapping of hail, as well as rain, is desirable in many instances. For example, hail mapping in the vicinity of a launch vehicle on the launch pad would help determine whether or not damage has occurred following a hail event. In addition to quantifying the size and quantity of hail, it is desirable to know where on the vehicle hail impacts may have occurred. A method that was previously developed, and that required multiple ground sensors, has been modified to accommodate a single sensor. The 3D extrapolation from a single (or multiple) ground sensor can then be compared to the 3D radar-generated spatial map.

The 3D hydrometeor size interpolation scheme described in previous work assumes that a minimum of three hydrometeor disdrometers (rain or hail) are required for successful interpolation/extrapolation of the hydrometeor distribution in time and space. By simply bypassing the "gravity interpolation algorithm" for multiple sensors, it is shown that good agreement between single sites vs. multiple sites vs. radar is obtained.

The software modification allows any number of sensors, from 1 to *N*, to be used in the 3D-DSD algorithm. As would be expected, the more sensors that are available, the better, but the requirement for a minimum of three sensors has now been eliminated. This disclosure demonstrates that multiple sensors are not required for successful implementation of the 3D interpolation/extrapolation algorithm. This is a great benefit, since it is seldom that multiple sensors in the required spatial arrangement are available for this type of analysis. This can be used in conjunction with a single sensor or an array of hail monitors, or single or multiple rainfall disdrometers.

This work was done by John Lane of ASRC Aerospace Corporation for Kennedy Space Center. Further information is contained in a TSP (see page 1). KSC-13244

Color-Changing Sensors for Detecting the Presence of Hypergolic Fuels

Chemochromic pigment indicates the presence of hypergols, improving workers' safety.

John F. Kennedy Space Center, Florida

Hypergolic fuel sensors were designed to incorporate novel chemochromic pigments into substrates for use in various methods of leak detection. There are several embodiments to this invention that would provide specific visual indication of hypergols used during and after transfer. The ability to incorporate these pigments into various polymer matrices provides a unique opportunity to manufacture nearly any type of sensor shape that is required. The vibrant color change from yellow to black instantaneously shows the worker the presence of hypergols in the area, providing the worker the ability to immediately evacuate the area.

The chemochromic pigments are prepared in powder or liquid form for addition into many different materials in different articles. With the ability to incorporate the pigment into a wide range of materials, the sensor can take any embodiment allowed by various manufacturing methods. For example,