(as determined by differential scanning calorimetry). This is in contrast to a freezing point of –45.7 °C for the pure acetonitrile solvent used in typical supercapacitor cells. This solvent system readily solubilizes salts commonly used in supercapacitor electrolytes, such as tetraethylammonium tetrafluoroborate (TEATFB) and lithium hexafluorophosphate.

Full electrolyte systems were formulated through the addition of TEATFB to the 1:1 solvent blend, over a range of salt concentrations. Coin cells were then filled with the various electrolytes for low-temperature electrical testing. Commercially available high surface area carbon-based materials were used as the electrode material, in conjunction with a polyethylene-based separator material. Representative DC discharge data for the 0.50 M concentration system have shown a highly linear discharge over a wide range of temperatures (with little fade in capacitance at the lowest measured temperatures).

This work was done by Erik Brandon, Marshall Smart, and William West of Caltech for NASA's Jet Propulsion Laboratory.

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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Designs and Materials for Better Coronagraph Occulting Masks

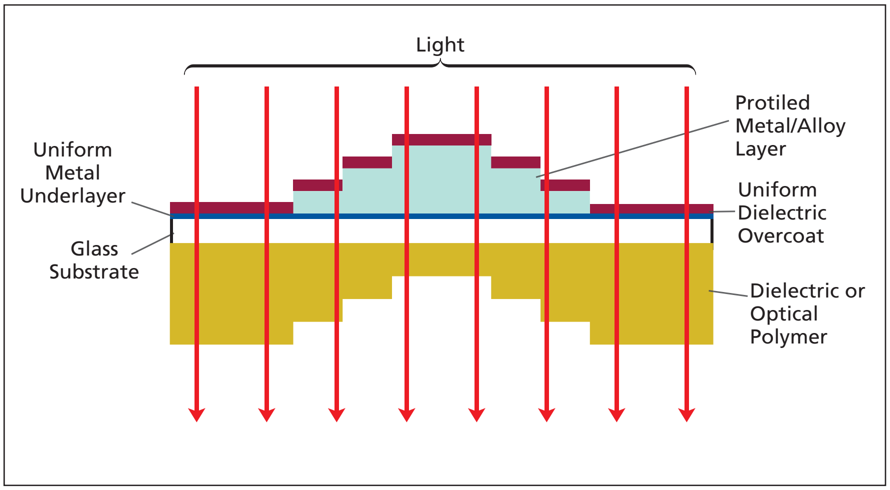
Optical density and phase profiles are achromatized over a broad wavelength range.

NASA's Jet Propulsion Laboratory, Pasadena, California

New designs, and materials appropriate for such designs, are under investigation in an effort to develop coronagraph occulting masks having broad-band spectral characteristics superior to those currently employed. These designs and materials are applicable to all coronagraphs, both ground-based and spaceborne. This effort also offers potential benefits for the development of other optical masks and filters that are required (1) for precisely tailored spatial transmission profiles, (2) to be characterized by optical-density neutrality and phase neutrality (that is, to be characterized by constant optical density and constant phase over broad wavelength ranges), and/or (3) not to exhibit optical-density-dependent phase shifts.

The need for this effort arises for the following reasons:

- Coronagraph occulting masks are required to impose, on beams of light transmitted through them, extremely precise control of amplitude and phase according to carefully designed transmission profiles.
- In the original application that gave rise to this effort, the concern has been to develop broad-band occulting masks for NASA's Terrestrial Planet Finder coronagraph. Until now, experimental samples of these masks have been made from high-energy-beam-sensitive (HEBS) glass, which becomes locally dark where irradiated with a high-energy electron beam, the amount of darkening depending on the electron-beam energy and dose. Precise mask profiles have been written on HEBS glass blanks by use of electron beams, and the masks have performed satisfactorily in monochromatic light. However, the optical-density and phase profiles of the HEBS masks vary significantly with wavelength; consequently, the HEBS masks perform unsatisfactorily in broad-band light.



Thin Metal and Dielectric Films would be deposited on a glass substrate. Their thicknesses would be stepped to obtain a specified spatial transmission profile with a uniform phase profile. This drawing is simplified and is not to scale.

The key properties of materials to be used in coronagraph occulting masks are their extinction coefficients, their indices of refraction, and the variations of these parameters with wavelength. The effort thus far has included theoretical predictions of performances of masks that would be made from alternative materials chosen because the wavelength dependences of their extinction coefficients and their indices of refraction are such that that the optical-density and phase profiles of masks made from these materials can be expected to vary much less with wavelength than do those of masks made from HEBS glass. The alternative materials considered thus far include some elemental metals such as Pt and Ni, metal alloys such as Inconel, metal nitrides such as TiN, and dielectrics such as SiO_2.

A mask as now envisioned would include thin metal and dielectric films having stepped or smoothly varying thicknesses (see figure). The thicknesses would be chosen, taking account of the indices of refraction and extinction coefficients, to obtain an acceptably close approximation of the desired spatial transmittance profile with a flat phase profile.

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