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Marshall Space Flight Center



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Elastic Light-Scattering Modulator: A Concept

A simple structure has been developed that can be used as an electrically-controlled light valve, to scatter both transmitted and reflected beams. Its operation is based on the physical phenomenon called frosting. Frosting has been observed by applying an electric field across an incompressible fluid. Because of the force of the surface charges induced by the electric field, the fluid surface deforms, until the force due to the surface charge is balanced by the surface tension forces of the fluid. Since the fluid is incompressible, there is no change in the average thickness of the fluid. Deformation, as a result, takes the form of a sinusoidal variation of thickness, i.e., the surface becomes rippled and appears to be frosty. The average period of the ripple is approximately twice the initial thickness of the fluid. The same effect occurs when the electric field is removed.

The basic constituent of the incompressible fluid is an elastomer containing small dispersed incompressible particles. The elastomer in this case is a special silicone rubber that vulcanizes at room temperature; it contains about 1 percent by weight of very fine grained (200 Å) silicate. This composition is diluted in cyclohexane, and the solution is then dip-coated onto the substrate. The elastomer film is sandwiched between two substrates serving as electrodes. Film thickness is approximately 1 μm .

Each substrate is made of glass covered with InO_2 (a transparent conductor) lines which are 2 mm wide. Thin gold-film lines, 200 Å thick and 2 mm wide, are deposited at right angles to the InO_2 lines. To prevent electrical discharge between the two electrodes, a second insulator is deposited between each substrate and the elastomer; at present, approximately 3 μm of poly-n-vinyl carbazole are used. Later, however, a much thinner insulating layer (probably SiO_2) will be tested, to reduce the operating voltage substantially.

As constructed, the device frosts when at least 200 V are applied to the two electrodes. Maximum light scattering is produced at 250 V. When used for light reflection, the device scatters light in the form of a halo around the reflected beam. The angle of the halo is inversely proportional to twice the thickness of the elastomer. The turn-on-time for the device i.e., the time for light to be scattered away from the normally reflected beam, is 1 ms; the turnoff time is also 1 ms. The device can be cycled 30 times per second for millions of cycles without degradation.

Notes:

1. This device may be of interest to the manufacturers of page compositors, alphanumeric displays, flat-panel displays, large-screen televisions, and optical input terminals for computers.
2. Requests for further information may be directed to:
Technology Utilization Officer
Marshall Space Flight Center
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Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457 (f)], to the David Sarnoff Research Center, Princeton, N. J. 08456

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