Mechanics

Rollable Thin Shell Composite-Material Paraboloidal Mirrors

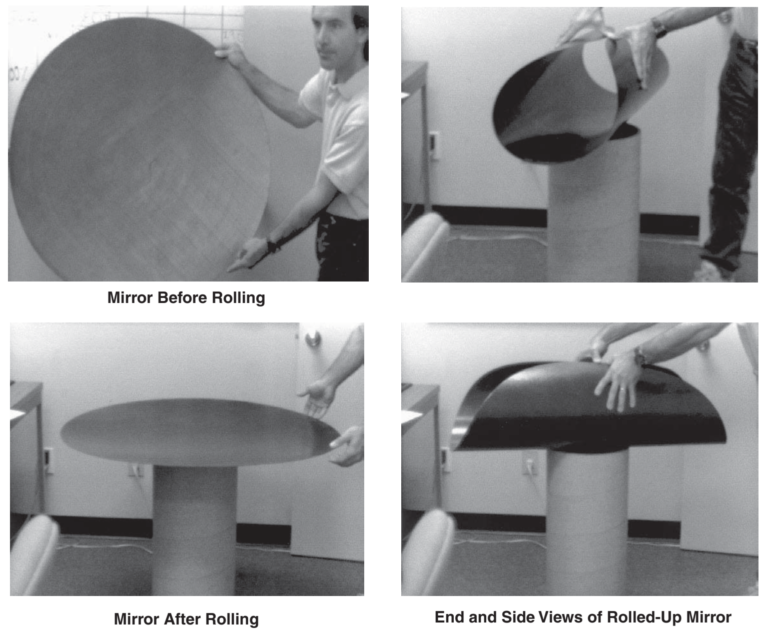
These lightweight focusing mirrors can be stored in fairly narrow cylinders.

NASA's Jet Propulsion Laboratory, Pasadena, California

An experiment and calculation have demonstrated the feasibility of a technique of compact storage of paraboloidal mirrors made of thin composite-material (multiple layers of carbon fiber mats in a polymeric matrix) shells coated with metal for reflectivity. Such mirrors are under consideration as simple, lightweight alternatives to the heavier, more complex mirrors now used in space telescopes. They could also be used on Earth in applications in which gravitational sag of the thin shells can be tolerated.

The present technique is essentially the same as that used to store large maps, posters, tapestries, and similar objects: One simply rolls up the mirror to a radius small enough to enable the insertion of the mirror in a protective cylindrical case. Provided that the stress associated with rolling the mirror is not so large as to introduce an appreciable amount of hysteresis, the mirror can be expected to spring back to its original shape, with sufficient precision to perform its intended optical function, when unrolled from storage.

A simple calculation yields a qualitative indication of the level of stress in, and the likelihood of permanent deformation of, a rolled mirror. The calculation in question is an estimate of the stress in a rolled flat sheet of the same composite material and thickness as those of the mirror shell. The compressive or tensile stress (S) in the radially innermost or radially outermost surface layer, respectively, is given by $S = Et/2r$, where E is the modulus of elasticity of the composite-material shell or flat sheet, t is the thickness of the shell or flat sheet, and r is the radius of curvature to which the shell or sheet is rolled. For a typical mirror diameter (D = 2 m) and shell thickness (t = 1 mm) rolled to a radius such that diametrically opposite points on the edge of the mirror just come into contact ($r = D/2\pi$), this equation yields $S \approx 0.016E$. This is a relatively small amount of stress and, as such, would not be expected to cause an appreciable permanent deformation.



A **Thin-Shell Composite-Material Mirror** was rolled, then unrolled without introducing visible permanent distortion of its optical surface.

The figure depicts stages of a demonstration in which a composite-material mirror of D = 90 cm, t = 1 mm, and a focal ratio (f number) of 1 was manually rolled as described above. Visual inspection after unrolling revealed no hysteresis. Further optical testing of the unrolled mirror was underway at the time of reporting the information for this article.

This work was done by Aden Meinel, Marjorie Meinel, and Robert Romeo of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
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Folded Resonant Horns for Power Ultrasonic Applications

Ultrasonic actuators can be made shorter.

NASA's Jet Propulsion Laboratory, Pasadena, California

Folded horns have been conceived as alternatives to straight horns used as resonators and strain amplifiers in power ultrasonic systems. Such systems are used for cleaning, welding, soldering, cutting, and drilling in a variety of industries. In addition, several previous *NASA Tech Briefs* articles have described instrumented drilling, coring, and burrowing machines that utilize combinations of sonic and ultrasonic vibrational actuation. The main advantage of a folded horn, relative to a straight horn of the same resonance frequency, is that the folded horn can