Lightweight, Self-Deploying Foam Antenna Structures

Advantages would include lightness, simplicity, reliability, compactness in stowage, and low cost.

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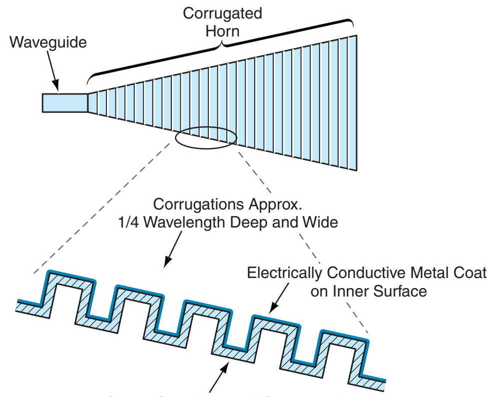
Lightweight, deployable antennas for a variety of outer-space and terrestrial applications would be designed and fabricated according to the concept of cold hibernated elastic memory (CHEM) structures, according to a proposal. Mechanically deployable antennas now in use are heavy, complex, and unreliable, and they utilize packaging volume inefficiently. The proposed CHEM antenna structures would be simple and would deploy themselves without need for any mechanisms and, therefore, would be more reliable. The proposed CHEM antenna structures would also weigh less, could be packaged in smaller volumes, and would cost less, relative to mechanically deployable antennas.



A **CHEM Corrugated Horn Antenna** would consist of a lightweight CHEM shell coated with metal on its inner surface.

The CHEM concept was described in two prior *NASA Tech Briefs* articles: "Cold Hibernated Elastic Memory (CHEM) Expandable Structures" (NPO-20394), Vol. 23, No. 2 (February 1999), page 56; and "Solar Heating for Deployment of Foam Structures" (NPO-20961), Vol. 25, No. 10 (October 2001), page 36. To recapitulate from the cited prior articles: The CHEM concept is one of utilizing open-cell foams of shape-memory polymers (SMPs) to make lightweight, reliable, simple, and inexpensive structures that can be alternately (1) compressed and stowed compactly or (2) expanded, then rigidified for use. A CHEM structure is fabricated at full size from a block of SMP foam in its glassy state [at a temperature below the glass-transition temperature (Tg) of the SMP]. The structure is heated to the rubbery state of the SMP (that is, to a temperature above Tg) and compacted to a small volume. After compaction, the structure is cooled to the glassy state of the SMP. The compacting force can then be released and the structure remains compact as long as the temperature is kept below Tg. Upon subsequent heating of the structure above Tg, the simultaneous elastic recovery of the foam and its shape-memory effect cause the structure to expand to its original size and shape. Once thus deployed, the structure can be rigidified by cooling below Tg. Once deployed and rigidified, the structure could be heated and recompacted. In principle, there should be no limit on the achievable number of compaction/deployment/rigidification cycles.

Thus far, several different designs of a 3.5-m-long CHEM conical corrugated horn antenna have been analyzed (see figure). A small CHEM structural antenna model was fabricated and a thin, electrically conductive layer of aluminum was deposited on the inner surface of the model. This structural model was then subjected to the compaction and deployment treatments described above to demonstrate the feasibility of a CHEM corrugated horn antenna.

This work was done by Witold Sokolowski, Steven Levin, and Peter Rand of Innovative Technology for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
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Electrically Small Microstrip Quarter-Wave Monopole Antennas

Inductive/resonant feeds make it possible to reduce sizes.

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Microstrip-patch-style antennas that generate monopole radiation patterns similar to those of quarter-wave whip antennas can be designed to have dimensions smaller than those needed heretofore for this purpose, by taking advantage of a feed configuration different from the conventional one. The large sizes necessitated by the conventional feed configuration have, until now, made such antennas impractical for frequencies below about 800 MHz: for example, at 200 MHz, the conventional feed configuration necessitates a patch diameter of about 8 ft (≈2.4 m) — too large, for example, for mounting on the roof of an automobile or on a small or medium-size aircraft. By making it possible to reduce diameters to between