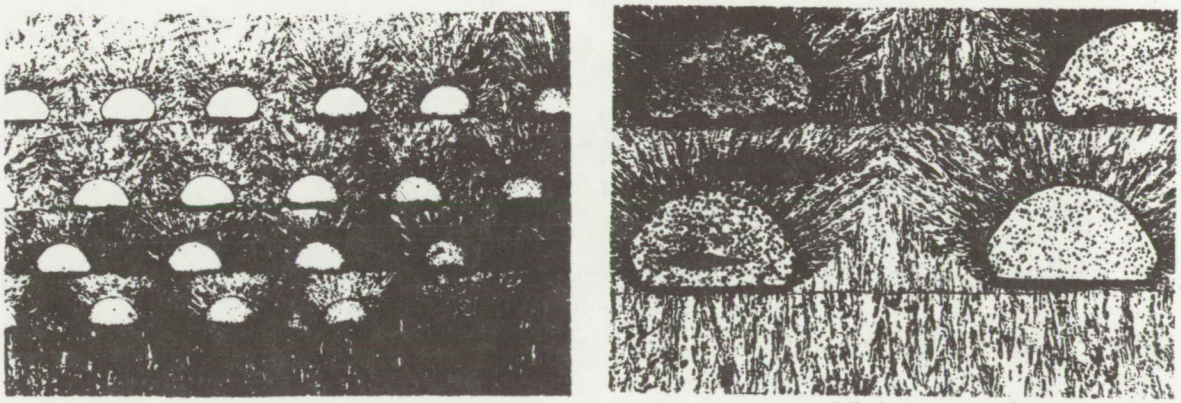
NASA TECH BRIEF

Lewis Research Center

High Strength, Wire-Reinforced Electroformed Structures



50X 150X

WIRE REINFORCED ELECTROFORMED NICKEL
(Wire Diameter 0.203 mm)

Electroforming is a low-cost and versatile process for fabricating complex metal structures such as regeneratively cooled rocket engine thrust chambers. However, use of the process is limited to relatively pure forms of metals such as nickel and copper which may be easily electrodeposited. For thrust chambers, structures are needed which have higher strength and lighter weight than provided by these materials.

One way to achieve higher strength, lighter weight structures is to incorporate reinforcing in the form of high strength wires embedded in the electroformed shell. The deign rules for such composite materials predict that a thirty-percent volume of wire reinforcing with four times the strength of the matrix material will produce a structure twice as strong as the matrix material alone. However, test cylinders fabricated by electroforming nickel over conventional round wires disclosed a serious problem. Voids occurred in the electroformed material underneath the wires and between wires at the junction with the underlying substrate, which seriously weakened the structure. With round wires, the rate of matrix metal deposition was uneven and less metal was deposited at the point of fiber-matrix intersection than on the remainder of the surface.

The problem was solved by using half-round reinforcing wires (see figure). Using the half-round wires, the electrodeposited matrix metal readily filled the spaces between the wires in intimate contact with the wires and without voids.

Test cylinders were fabricated of electroformed nickel with half-round type 302 stainless steel circumferential wire reinforcing. The figure shows a photo-micrograph of a cross-section of a cylinder wall reinforced with 0.203 mm (0.008 in) diameter wire with one diameter spacing between wires. Comparisons of hoop strength indicate a minimum of fifty percent increase in strength for the wire-reinforced cylinder over cylinders of the same material without wire reinforcing.

Notes:

1. This procedure can be used to fabricate high strength, light weight pressure vessels or other structures. It combines the advantages of electroforming with the high strength of commonly available wire to produce non-welded shell structures of various geometric shapes for high pressure uses.

(continued overleaf)

2. Further information is available in the following report:
   NASA CR-134480 (N74-17195), Development of Improved Electroforming Technique
   Copies may be obtained at cost from:
   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B74-10018
3. Specific technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B74-10018

Patent Status:

NASA has decided not to apply for a patent.

Source: J.M. Kazaroff and R.A. Duscha
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