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# NASA TECH BRIEF

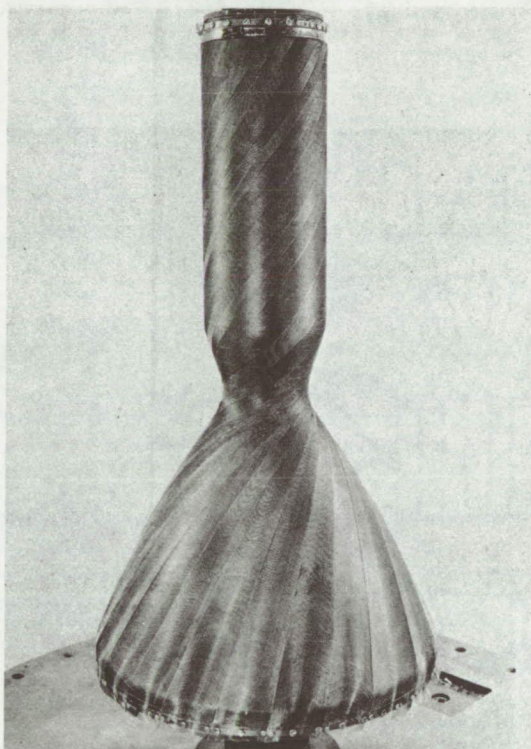
*Lewis Research Center*



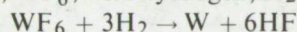
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## Fabrication of Large Tungsten Structures by Chemical Vapor Deposition

Process details have been developed for the fabrication of a large, pure-tungsten, rocket-motor chamber shell (or similar geometric structure). The process involves the chemical vapor-phase deposition of tung-



Graphite Mandrel with Tungsten Screen Assembled  
sten, which is accomplished by reducing tungsten hexafluoride,  $WF_6$ , with hydrogen,  $H_2$ :



Metallic tungsten of essentially 100% purity and density is produced in this reaction and is built up as

a dense deposit on a heated mandrel assembly.

The initial fabrication step is to machine a block of graphite into a mandrel having an external configuration and dimensions corresponding to the inside dimensions of the desired tungsten structure. The graphite mandrel is then spirally wrapped with strips of tungsten mesh, and electrical resistance heating elements are inserted into predrilled holes in the graphite. The assembly, which is mounted to rotate about its vertical axis (axis of symmetry) in an evacuated vapor-deposition retort, is heated to approximately 617 K (650° F) and slowly rotated adjacent to a contoured spray nozzle. A metered gaseous mixture of hydrogen and tungsten hexafluoride (which is a gas at room temperature) is sprayed from the nozzle onto the heated rotating mandrel. As the gas mixture contacts the hot outer surface of the wrapped mandrel, the tungsten hexafluoride is reduced by the hydrogen, and pure metallic tungsten is uniformly deposited on the surface of the tungsten mesh wrapping. The deposition process is continued until all voids in the mesh are filled and the desired thickness of the reduced tungsten is deposited. Unreacted  $WF_6$  is removed from the exhaust gases by a cold trap, after which the gases are bubbled through a lime solution to neutralize the HF. The completed assembly is removed from the retort and the graphite mandrel is separated by machining, leaving a tungsten shell structure of the required shape and thickness.

### Notes:

1. A shell with dimensions 13.33 cm (5.25 in.) diameter at the small end, 40.6 cm (16 in.) diameter at the nozzle exit, and 61 cm (24 in.) length, is the largest structure of this type known to have been constructed to date. The shell served as the liner

(continued overleaf)

wall of a regeneratively cooled hydrogen-fluorine rocket thrust chamber.

2. Fabrication of the tungsten shell is another application of the chemical vapor deposition process summarized in NASA Tech Brief B67-10232. Variants of this process can generally be used to build up, seal, or bond refractory metals at temperatures well below the transition temperatures of the base metal substrates.
3. The following documentation may be obtained from:

National Technical Information Service  
Springfield, Virginia 22151  
Single document price \$3.00  
(or microfiche \$0.95)

**Reference:**

NASA-CR-72742 (N71-14135), Investigation of Advanced Regenerative Thrust Chamber Designs

4. Technical questions may be directed to:  
Technology Utilization Officer  
Lewis Research Center  
21000 Brookpark Road  
Cleveland, Ohio 44135  
Reference: B71-10212

**Patent status:**

No patent action is contemplated by NASA.

Source: V. R. Stubbs, W. J. Lewis, and  
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under contract to  
Lewis Research Center  
(LEW-11239)