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AEC-NASA TECH BRIEF

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Thoriated Tungsten Tube Provides Improved High Temperature Thermocouple Sheath

The problem:

To produce a small-diameter tungsten thermocouple sheath that is capable of operating up to 5000° R in a hydrogen and graphite environment. Pure tungsten and pure tantalum have the temperature capability. However, in this temperature range, tungsten embrittles severely from grain growth and tantalum hydrides and carbides are formed too readily. The result is that both materials become structurally unsound and are therefore useless in this application.

The solution:

Utilize thermocouple tubing, nominally 0.095-inch diameter, made of thoriated tungsten with a very fine grain structure.

How it's done:

By adding 2 percent thoria (ThO_2) to pure tungsten, a sintered tubing billet can be made that will produce a fine-grain hot-extruded tungsten tube. The 2 percent thoria acts as a grain growth inhibitor by creating barriers to grain growth at the grain boundaries. This property has been recognized and utilized in the manufacture of filament wire for vacuum tubes and light bulbs. Under vacuum, however, thoria decomposes rapidly above about 4000° R.

At moderate positive hydrogen pressures the thoria does not undergo decomposition and therefore remains as an effective deterrent to grain growth. Carbon attacks the tungsten, but the resultant carbide is of finer grain size which is less likely to cause structural failure of the thermocouple sheath.

This tubing remains ductile above 4000° R and resists both grain growth and carbiding at temperatures extending up to 5000° R for 1 hour. Even after prolonged exposure to temperature, the microstructure of the thoriated tube is superior to that of pure tungsten. Hydrogen does not react chemically with the tungsten or thoria.

Note:

Inquiries concerning this innovation may be directed to:

Technology Utilization Officer
AEC–NASA Space Nuclear Propulsion Office
U.S. Atomic Energy Commission
Washington, D. C. 20545
Reference: B67-10627

Patent status:

No patent action is contemplated by AEC or NASA.

Source: G. J. Zellner
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