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NASA TECH BRIEF

Wire Bundles Formed into Grids with Minute Interstices

The problem: To produce grids or filters for use in ion engines. Because the ion current density for a given applied voltage varies inversely with the size of the grid interstices, they must be extremely small for efficient operation. Theoretical dimensions are interstices of 0.5 to 2 microns in cross sectional dimension uniformly spaced at 2 to 6 microns.

The solution: A process that uses a bundle of closely packed parallel wires and deforms the ends of the wires to restrict the interstices to substantially uniform and minute dimensions.

How it's done: A bundle of 0.0005-inch tungsten wires are encased in a 0.25-inch i.d. tantalum tube with a wall thickness of 0.185 inch. The tantalum tube is moved lengthwise through a set of three swaging rolls that substantially reduce the tube diameter and thus transversely pack and distort the confined wires. The tube is then placed in a bath of molten copper where capillary attraction causes the molten copper to enter the interstices of the wire bundle. The tube is removed from the bath, cooled, and the tantalum tube is removed by grinding to expose the bundle of copper-bonded wires. A diamond saw is used to cut the bundle transversely into a number of slices or units. Action of the diamond saw tends to deform the ends of the wires in enlarging them by a transverse spreading or smearing. This causes the enlarged wire ends to extend laterally over the copper that fills the interstices. The sliced units are placed in a furnace equipped with a vacuum pump and sintered in two stages, the first at 1500°C with the pressure at 10^{-4} mm Hg for 30 minutes, and the second at 2000°C for 15 minutes at the same pressure. In the sintering process the copper bonding material is evaporated from the interstices and considerable shrinkage and densification of the wire bundle occurs. As this takes place, the wires coalesce at points of mutual contact, leaving them bonded together by the metal bridges at their outer ends and fused together at other points to form a unitary metal grid with minute interstices.

Note: Porous metal structures made by this process will be useful as fuel cell electrodes, diffusion membranes, and catalysts.

Patent status: Title to this invention has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C. 2457 (f)), to Electro-Optical Systems, Inc., 300 North Halstead Street, Pasadena, California, 91107.

Source: Hoyt H. Todd of Electro-Optical Systems, Inc. under contract to Western Operations Office (WOO-089)

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