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Method for Controlling Density and Permeability of Sintered Powdered Metals

An improved, relatively low-cost method has been developed to produce porous metals with predetermined pore size, pore spacing, and density, utilizing powder-metal processes. The need for such materials exists for a number of applications such as contact ionizers, transpiration and ablative cooling, boundary control surfaces, and fluid filters. With this method, the pore size, shape, and spacing are predetermined by adding an inert volatile material of the desired pore size and geometry prior to pressing and sintering.

The method was developed during experiments with tungsten powders to produce porous tungsten ionizers. Initially, closely sized spherical tungsten powders were compacted and sintered to make the porous material. High cost of the spherical powders and technical difficulties in producing a low-density material with controlled pore size and spacing led to investigation of other methods.

This method utilizes sized, hydrogen-reduced, angular tungsten powders costing much less than spherical powders and having particle sizes that can be readily controlled during manufacture of the powders. The method of producing the desired material is as follows:

1. Metal powders of selected size are blended with relatively inert particles that will give pores of the desired size and geometry. The final density is determined principally by the amount of inert material incorporated in the metal powder. In actual practice, flake copper has been utilized as the inert material, and has been blended with angular tungsten powder of 0.8 micron average size.
2. The metal powder mixture is pressed hydrostatically to produce a compact of the desired size and shape.
3. The pressed compact is presintered at a temperature sufficiently high to produce grain growth and densification in the powder mass surrounding each inert particle, but at a temperature below the melting or volatilization temperature of the inert particles. Tungsten powderflake copper mixtures for example are presintered in the temperature range of 1850° to 1950°F, which is below the melting point of copper, but above the minimum sintering temperature of the tungsten powder compact. This procedure results in the establishment of a sintering pattern within the tungsten powder surrounding each inert particle.
4. Upon completion of presintering, the temperature is raised sufficiently to evaporate the pore-forming inert particles and produce the desired densification of the pressed compact.
5. Machining the compact to final dimensions is accomplished by infiltrating the porous compact with copper or the more inert gold, machining to the desired geometry, and reevaporating the infiltrated metal at high temperature in vacuum.

Porous compacts of less than 70 percent theoretical density were produced in sizes of up to $4 \times 2 \times 1/2$ inch.

Note:

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(continued overleaf)

Questions concerning this innovation may also be directed to:

Technology Utilization Officer
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Patent status:

No patent action is contemplated by NASA.

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