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AEC-NASA TECH BRIEF

Improved Method for Producing Metal-Reinforced Ceramics

The problem:

To devise a method for producing metal-reinforced or metal-filled ceramics which have minimal or no porosity. Generally metal-reinforced ceramics are made by sintering a compacted mixture of metal and ceramic powders. During the sintering process an oxide film forms on the metal. This film prevents the free flow of the molten metal and inhibits complete infiltration of the ceramic matrix. This method produced metal-reinforced ceramics with 10 to 15 per cent void space volumes. The void spaces decrease the effective cross sectional area and act as stress concentrators. This limits the use of metal-filled ceramics to applications not requiring high material strength and impact resistance. Completely filled metal-reinforced ceramics would be inherently stronger and more resistant to brittle fracture.

The solution:

A vacuum impregnation process produces metal-reinforced ceramics with only 3 per cent void space volumes.

How it's done:

A ceramic powder is pressed to form a porous compact of the desired shape. The compact and a quantity of filler metal are placed in a vacuum chamber. The chamber is heated to a temperature above the melting point of the metal (generally to 1.5 times the metal melting temperature) and is evacuated to a pressure below 10^{-6} torr. The vacuum evaporates the oxide film from the metal surface allowing the molten metal to flow freely into the void spaces of the ceramic compact.

Aluminum-filled boron carbide ceramic bodies produced by the vacuum impregnation process exhibit porosity of 3 per cent with an estimated aluminum content of 35 to 40 per cent by volume. Studies of several metal-ceramic systems indicate that a vacuum of less than 10^{-6} torr is essential to achieve satisfactory infiltration of the void spaces.

The method described may be used to produce metal-reinforced ceramics for high temperature or structural applications such as furnace supports and armor.

Note:

Requests for further information may be directed to:

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Reference: TSP72-10234

Patent Status:

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