NEWS from ARO-FE (OCT 13, 2000): Functionally Graded Material (FGM)

Japanese materials scientists, in the Sendai area of Japan, proposed the concept of functionally graded materials (FGMs) in 1984 as means of preparing thermal barrier materials.

This information paper was written as a result of a recent meeting Dr. G. D'Andrea held with a representative of the Sumitomo Coal Mining Co

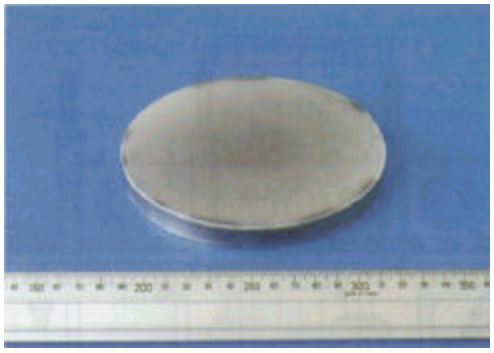
- Large-size ceramic/metal bulk FGMs have been fabricated on a recently developed and world's largest Spark Plasma Sintering (SPS) system. The fully automated SPS system belongs to the Sumitomo Coal Mining Co., Ltd. and Izumi Technology Co., Ltd.
  Spark Plasma Sintering (SPS) is a newly developed process, which makes possible sintering and sinter-bonding at low temperatures. It is regarded as a rapid sintering method, using the self-heating action from inside the powder, similar to self-propagating high temperature synthesis (SHS) and microwave sintering.

- In the past, several porous and other combinations of bulk FGMs have been processed using SPS such as ZrO2/Stainless steel, ZrO_2/TiAl, ZrO_2/Ni, Al_2O_3/Ti, WC/Co, WC/Co/steel, Al/polyimide, Cu/polyimide and nano-composites. However, most of the specimen sizes were small. They ranged from 20 to 30mm in diameter. Lately, disk-shaped parts - made of ZrO_2(3Y)/stainless steel FGM - with diameters of 100mm and 150mm and thickness of approximately 17mm and 15mm, have been successfully consolidated in rapid sintering time maintaining high quality and repeatability. The SPS heating-up and holding time totaled less than one hour.

  FGM by SPS provide new heat & wear resistant materials that can withstand high temperature environments. Potential applications are in design of high efficiency engines, ceramic turbine components, mold & die devices for industrial use, armor and armament components for defense use and many more.

- The SPS process is expected to find increased use in the fabrication of large-size FGMs. Moreover, it can provide a wide range of new materials including polymer-metallic composites, electronic, magnetic and amorphous materials. Sumitomo/Izumi will deliver the SPS systems and/or FGM components in commercial basis upon request.

Fully Automated FGM Manufacturing System



150mm diameter ZrO_2(3Y)-Stainless steel FGM

Layering Condition of 150mm diameter ZrO_2(3Y)-Stainless steel FGM

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