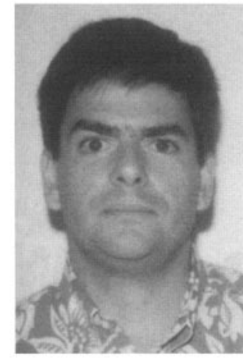
Editorial

Thermal Spray Processing of Nanostructured Materials

The study of nanostructured materials represents one of the fastest growing fields in materials science. This explosion of activity results, not only from the extraordinary properties that can be realized from these materials, but also from the many recent successes in synthesizing nanostructured powder. Today, dozens of companies are engaged in nanoscale powder and particle synthesis by a wide variety of techniques, some of them now fully commercial. Our ability to exploit these unique materials is now limited, not by the ability to synthesize nanostructured materials, but by the ability to process that powder into useful products.



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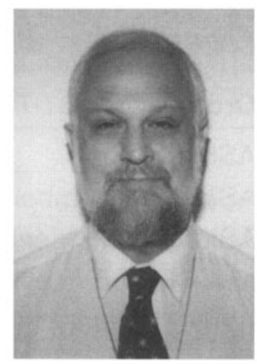
Nanostructured materials are generally defined as any material containing a physical feature smaller than 100 nm. This feature can be a particle size, fiber or layer thickness, or polycrystalline grain size. The choice of 100 nm is not as arbitrary as it might seem. As the scale of the microstructure falls below this boundary, many properties begin to diverge rapidly from that which is seen in more conventional materials. There are several reasons for this. One reason is that the number of atoms found at boundaries becomes unusually large. For example, in a polycrystalline material with a grain size of about 5 nm, as many as 50% of the atoms are at grain boundaries. The very high surface area (including grain boundaries and other "buried interfaces") profoundly affects diffusion related processes (sometimes by more than ten orders of magnitude). A more subtle reason for the change is that physical phenomena are governed by mechanisms that exhibit a characteristic length scale, typically of the order of 100 nm or less. As the physical scale of the material falls below this characteristic length, all properties associated with this mechanism begin to change rapidly with feature size. This trend accelerates rapidly as the physical length scale is further reduced.



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The most difficult problem encountered in trying to process a nanoscale powder into a fully dense, well consolidated bulk solid or coating is how to achieve densification without excessive grain growth. The driving forces for grain growth are inversely related to particle size, and become prodigious in a nanoscale material. Moreover, one must accomplish the task by a cost effective, scalable process. Thermal spray processing is an ideal technique for producing thick, nanostructured, polycrystalline coatings. This is because the time that the material is exposed to high temperature is too short to permit extensive grain growth. Another benefit is that some of the most useful properties of nanostructured materials are actually surface properties, for example, hardness and wear resistance. Initial attempts to fabricate nanostructured coatings by various types of thermal spray have been quite successful (in some cases spectacularly so).

The Engineering Foundation held a conference on thermal spray processing of nanostructured materials on 3-7 August 1997 at Davos, Switzerland. The purpose of the conference was twofold. The first was to assess the current state of the art and to identify technical issues that need to be addressed in order to successfully develop and implement the technology. The second was to introduce the thermal spray and nanostructured materials communities to each other and facilitate collaborative efforts. The abstracts from this conference are presented in this issue of *JTST*. A second conference of what is hoped to be an ongoing series is being planned for August 1999 in Quebec.

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