Optimizing powder metallurgy: Solving problems with Additive Manufacturing of Ti alloys and Hot Isostatic Pressing of Ni-base superalloys

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This paper describes research undertaken to solve problems limiting the application of two methods of manufacture using powder metallurgy, namely additive manufacturing (AM) and hot isostatic pressing (HIP). Regarding the first of these, namely AM, a limitation regarding the use of this approach for the manufacture of Ti alloy components involves the typical production of coarse columnar microstructures aligned paralel to the deposition direction. We have made use of alloying to effect a columnar to equiaxed transition, and examples of the application of this approach to yielding equaixed microstructures in the base alloy Ti-64 will be presented. The consequences of the addition of solute to Ti-64 have been studied and results of these studies will be presented. The most significant phenomenon that limits the application of HIP for the manufacture of rotating components of Ni-base superalloys is the coincidence of prior particle boundaries (ppb's) with high angle grain boundaries. The origin of the ppb's has been shown to be in part due to the cleanliness of the powders used in the HIP process, and this cleanliness has been revealed in detail by a combination of the application of low accelerating voltages and novel in-column detectors in the scanning electron microscope. It has been shown that the degree of coincidence of ppb's with grain boundaries may be significantly reduced by use of the relatively clean powders produced by the PREP process.