Optimizing the performance of metastable beta titanium alloys through processing (e.g., additive manufacturing) and heat-treatment

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Metastable beta titanium alloys offer a range of attractive properties for structural applications. This paper provides an understanding of the origin of these properties, focusing on the differences between metastable beta and alpha/beta alloys. Of course, it is important to realize optimum properties in processed materials, and in this talk, we focus on Additive Manufacturing (AM) of components, with a focus on realizing optimum properties. In the case of titanium alloy components, the application of essentially all industrially competitive techniques for additive manufacturing result in characteristic defects, being coarse columnar grains (in the direction of deposition), porosity, and residual stresses. In this paper, ways of avoiding coarse columnar grains has been addressed. The proposed solution involved the application of computational thermodynamics to identify which alloying additions to titanium alloys result in an increase in the freezing range of the given alloy base, such that a columnar to equiaxed transition (CET) may be effected. These alloying additions, mainly eutectoid formers, have been found at critical concentrations, to cause a CET to occur, resulting in a relatively fine equiaxed microstructure. While the refined microstructure is attractive, there are consequences associated with this alloying approach, involving the precipitation of intermetallics during subsequent heat-treatments, and a change in the character of the specific titanium alloys. It will be shown that a very attractive metastable beta alloy results as a result of this alloying approach, and the properties of this alloy will be presented and discussed.