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AN INVESTIGATION OF THE MICROSTRUCTURE OF SOLIDIFIED TI6AL4V ALLOY AFTER THERMAL PROCESSING UNDER REDUCED GRAVITY CONDITIONS

Abstract

The following research is part of the REXUS/BEXUS programme, which is realised under a bilateral Agency Agreement between the German Aerospace Center (DLR) and the Swedish National Space Board (SNSB). EuroLaunch is a cooperation between the Esrange Space Center of SSC and the Mobile Rocket Base (MORABA) of DLR and it is responsible for the campaign management and operations of the launch vehicles. A sounding rocket scheduled to fly in May 2014 will carry an experimental setup containing a 25 W LASER diode that will be used to melt and weld Ti6Al4V samples under reduced gravity conditions. The principal experimental objective is to understand and, thus quantify the role gravity has in the formation of microstructure in a solidifying alloy. For this purpose, two experiments are conducted, one in an Earth-based laboratory under normal gravity conditions and one in the flight environment of the REXUS rocket, where we benefit from a miligravity interval, in which gravity-induced convection effects that affect the stability of the dendritic growth and crystallographic orientation are considerably reduced. Moreover, a control-volume-based Boundary Element Method (Mochnacki Majchrzak; 2007b) was used to simulate the structure formation in an alloy as a result of solidification. Since no convection effects were accounted for in the mathematical model we expect the experimental results from the rocket flight to be a valid test for the accuracy of the numerical method. A Scanning Electron Microscope (SEM) and a Transmission Electron Microscope (TEM) were employed in order to characterize the microstructure of the samples. The expected differences in the geometry of the structure (in terms of uniformity, isotropy

of the growth pattern, fineness) are to be then correlated with the changes in the mechanical properties of the Ti alloy that are to be quantified from micro hardness tests, tension tests, bending tests. In conclusion, the current investigation aimed at understanding how Ti alloys transform when thermally processed in the absence of convection is expected to yield important theoretical and experimental results in the field of material science.