MICROWAVE PROCESSING OF HIGH ENTROPY ALLOYS: A POWDER METALLURGY APPROACH

P. Veronesi[(1)], R Rosa[(1)], E. Colombini[(1)], C. Leonelli[(1)] and M. Garuti [(2)]
(1) Dept of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia, Italy
http://www.ing.unimore.it
(2) MKS, Alter Products, Via P. e M. Curie, 8, 42122 Reggio Emilia, Italy
http://www.mksinst.com/product/Catalog.aspx?catalogID=63

High entropy alloys (HEAs)are solid solution alloys that contain more than five principal elements in equal or near equal atomic percent (at.%). Their mechanical properties can be different from the ones of the constituent elements. The type of structure results the dominant factor for controlling the strength or hardness of HEAs, being the BCC-structured ones characterized by very high yield strengths and limited plasticity, and the FCC ones presenting low yield strength and high plasticity.
Conventional processing routes for HEAs can be from the liquid state (mainly arc melting and plasma spray), from the solid state (mainly high energy milling followed by HIP), from the gas state (sputtering techniques), and from electrochemical process.
The present paper investigates the possibility to apply microwave heating of powder metal mixtures to rapidly prepare high entropy alloys, comparing the results applying 5.8 or 2.45 GHz frequency. A microwave single mode TE_{10n} applicator was used in both cases, positioning the sample in predominant electric field maxima region. Load was composed of loose or pressed powders of Al, Co, Cu, Ni, Fe, previously admixed in an alumina jar under protective atmosphere.
Results showed that using the 5.8 GHz frequency synthesis occurred in much reduced times and with a better elemental distribution homogeneity compared to the 2.45 GHz samples. Pressure applied during forming resulted an important parameter, as it determines the effective microwave penetration depth in the samples. In some cases, prolonging the microwave exposure time, it was possible to achieve complete melting of the load, thus achieving the maximum homogeneity.