EFFECT ON NANOINDENTATION IN LA$_2$O$_3$-REINFORCED W AND W–V ALLOYS PRODUCED BY HOT ISOSTATIC PRESSING

Javier Martinez-Gómez. Universidad Internacional SEK Ecuador, Campus Miguel de Cervantes, Ecuador
Ángel Muñoz. Departamento de Física, Universidad Carlos III de Madrid, Avda. de la Universidad 30, Spain
Miguel Ángel Monge. Departamento de Física, Universidad Carlos III de Madrid, Avda. de la Universidad 30, Spain
Begoña Savoini. Departamento de Física, Universidad Carlos III de Madrid, Avda. de la Universidad 30, Spain
Ramiro Pareja. Departamento de Física, Universidad Carlos III de Madrid, Avda. de la Universidad 30, Spain

Key Words: ODS tungsten alloys, Refractory metals, Nanoindentation, HIP.

W is a principal candidate material for fabricating plasma facing components (PFC) in a future fusion power reactor due to its high melting temperature, good thermal conductivity, thermal stress resistance, low tritium retention and high temperature strength [1]. For these applications, the structural materials should have an operating temperature window 873–1600 K and a ductile brittle transition temperature (DBTT) in the interval 573–673 K, as well as a recrystallization temperature (RT) above 1600 K [2]. La$_2$O$_3$ dispersion or Al, K, Si doping can improve the mechanical strength and increase the tungsten RT, although the DBTT appears not to be lowered [3]. Most of these W alloys were prepared by powder metallurgy methods, in particular by ball milling and subsequent pressure less sintering or hot isostatic pressing (HIP) [3]. Recently, W and WTi alloys reinforced with Y$_2$O$_3$ have been sintered by HIP [4]. The use of Ti as sintering activator and the Y$_2$O$_3$ dispersion result in full dense materials exhibiting improved mechanical properties and oxidation resistance [5]. However, the Y$_2$O$_3$ particles in a W matrix appear to be unstable at temperatures above 1600 K becoming into coarse particles of complex W–Y and W–Y–Ti oxides, which could worsen the mechanical properties. This drawback may be avoided if V is used as sintering activator. The V–W system exhibits an isomorphous phase diagram with a continuous range of solid solution [6].

The aim of the present work is to produce W and W–V alloys reinforced with La$_2$O$_3$ particles and investigate their microstructure and thermal stability in order to obtain a structural material with favorable properties to be used for developing PFC. W and W–V alloys reinforced with La$_2$O$_3$ particles have been produced by MA and subsequent HIP at 1573 K and 195 MPa. The microstructure of the consolidated alloys has been characterized by scanning electron microscopy, energy dispersive spectroscopy analyses and X-ray diffraction. The mechanical properties were studied by nanoindentation measurements. The results show that practically full dense billets of W–V, W–V–La$_2$O$_3$ and W–La$_2$O$_3$ alloys can be produced. The microstructure analysis has shown that islands of V are present in W–V and W–V–1La$_2$O$_3$ alloys. In W–1La$_2$O$_3$ islands of La$_2$O$_3$ are also present. The nanohardness of the W matrix increases with the addition of V, while decreases with the addition of La$_2$O$_3$.

References