Surface hardening of AZ31 Mg by PdCuSi thin film metallic glass coating

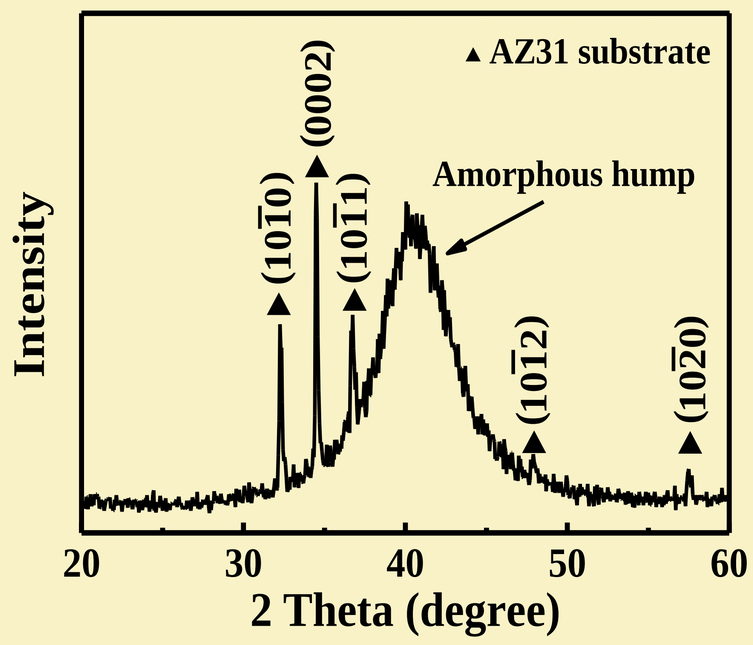
H. J. Pei, Y. C. Chang, B. Y. Chen, and J. C. Huang*

Department of Materials and Optoelectronic Science; Center for Nanoscience and Nanotechnology, National Sun Yat-Sen University, Kaohsiung, Taiwan 804, RO China

Abstract

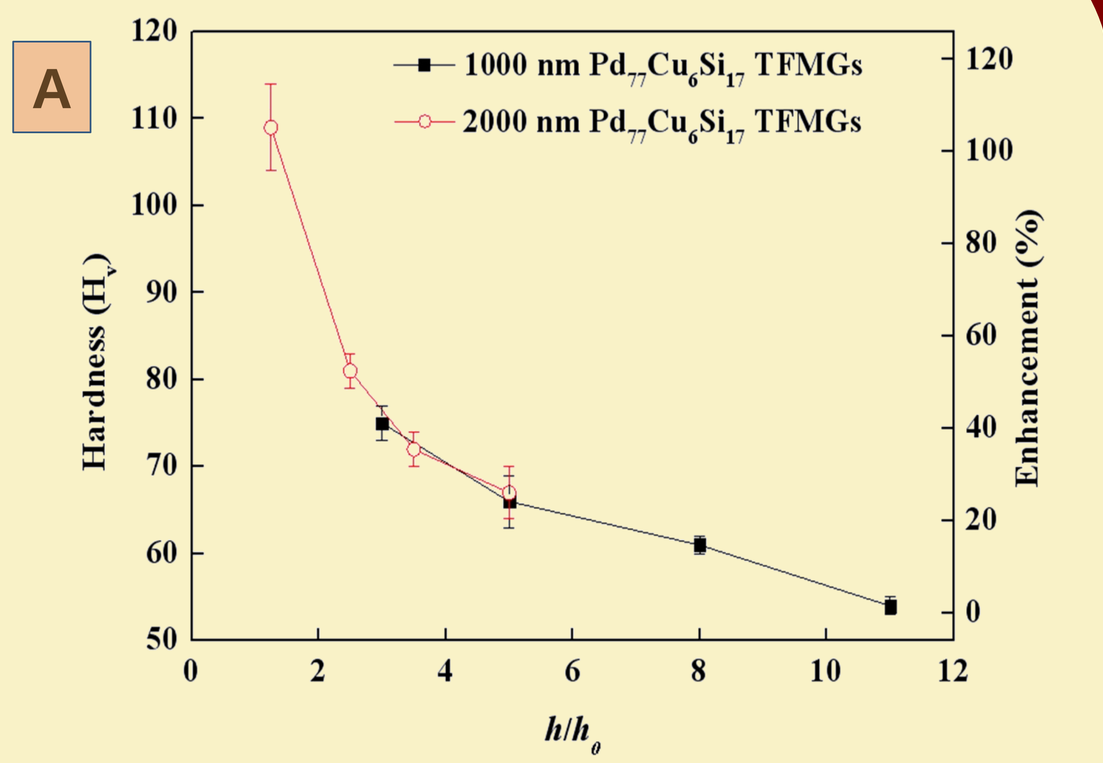
To improve the surface hardness/wear properties and oxidation/corrosion resistance of the AZ31 magnesium alloy, $Pd_{77}Cu_6Si_{17}$ (PCB) thin film metallic glasses (TFMGs) are selected as a hard coating utilizing the high hardness and good corrosion resistance. Both microhardness and nanoindentation loadings are conducted. It is demonstrated that the surface hardness of AZ31 Mg can be improved by more than 100% by sputtering deposition of the 1-2 μm $Pd_{77}Cu_6Si_{17}$ TFMGs. The ratio of indented displacement h to film thickness h_o, denoted as h/h_o, appears to be a useful indicator in the evaluation of hardness of materials. When h/h_o is larger than 1, most films do not show catastrophic crack, with numerous shear bands on the indentation mark. The induced shear bands provide a moderate deformation and prevent the films from cracking.

Structure Determination



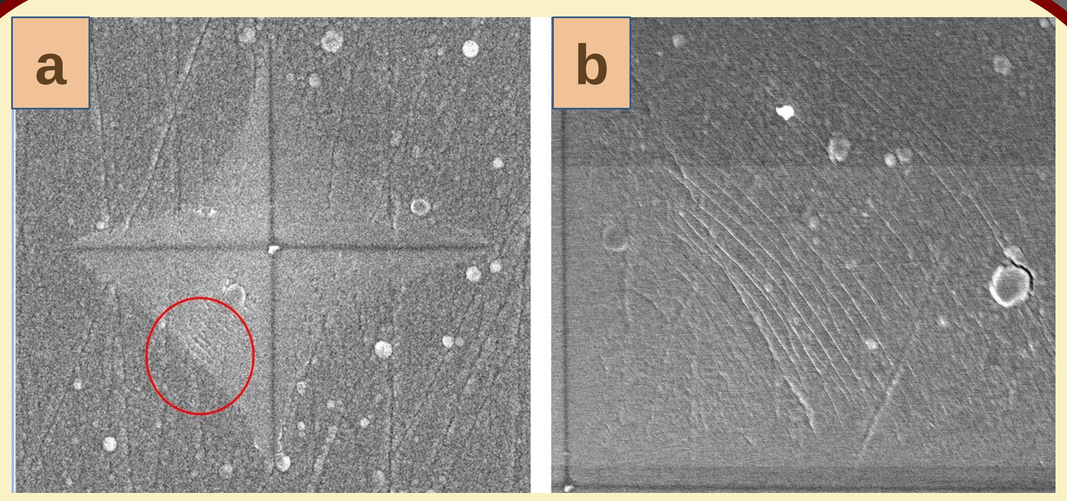
XRD pattern of the $Pd_{77}Cu_6Si_{17}$ thin film deposited on the AZ31 substrates.

Hardness Analyses

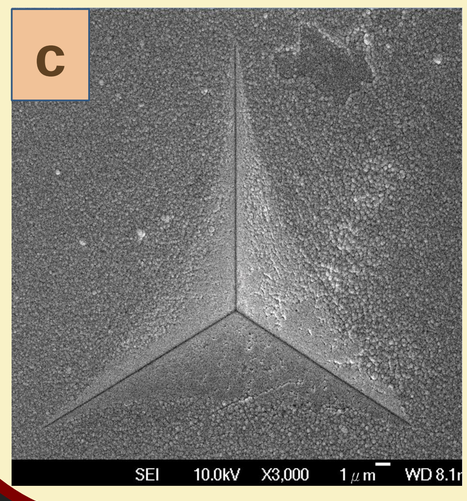


(A) The hardness-h/h_o curve of the $Pd_{77}Cu_6Si_{17}$ TFMGs 1000, and 2000 nm in thickness, obtained from the microhardness tests.

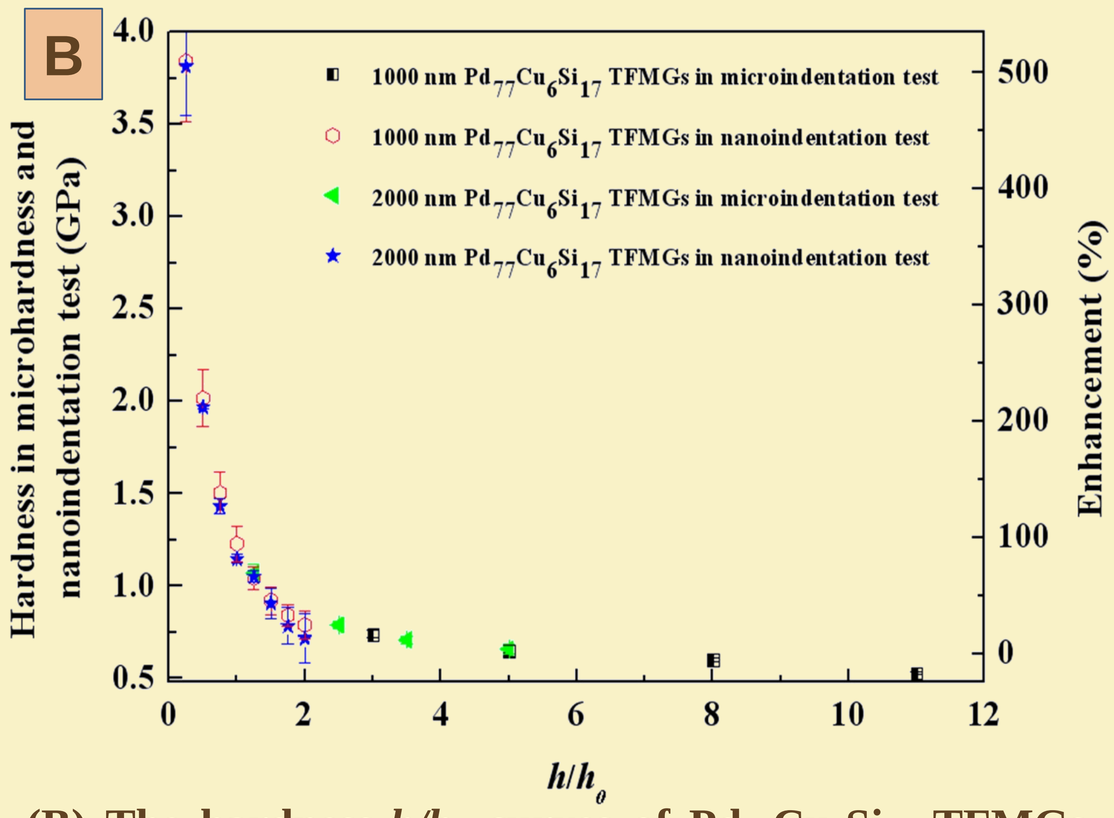
Morphology Observations



SEM micrographs of PCS-2000 under microhardness loading, at (a) 10 g, h/h_0 ~1.25, and (b) 100 g, h/h_0 ~5.



(c) SEM micrograph of PCS-2000 under nanoindentation at h/h_0 ~2.



(B) The hardness-h/h_o curves of $Pd_{77}Cu_6Si_{17}$ TFMGs, 1000 and 2000 nm in thickness, obtained from the microhardness and nanoindentation tests.

Conclusions

1. In the present investigation, the $Pd_{77}Cu_6Si_{17}$ TFMG can really be used as a protective film to enhance the hardness of AZ31. In addition to hardness enhancement, the shear bands provide a moderate deformation to prevent the film from cracking fiercely.
2. From the coherence in microhardness and nanoindentation test, h/h_o is a key point to determine the hardness of the system rather than simply film thickness. This result represents the hardness can be evaluated if penetration depth of indentation is known beforehand.