

Positronium formation in nanostructured metals

J. Čížek^{1,*}, O. Melikhova¹, P. Hruška¹, M. Vlček¹, W. Anwand², O. Liedke²,
M. Novotný³, J. Bulír³ and Y. Cheng⁴

¹*Faculty of Mathematics and Physics, Charles University,
V Holešovičkách 2, 18000, Praha 8, Czech Republic*

²*Institute of Radiation Physics, Helmholtz-Zentrum Dresden-Rossendorf
Bautzner Landstr. 400, 01328 Dresden, Germany*

³*Institute of Physics, Academy of Sciences of the Czech Republic,
Na Slovance 2, 182 21 Prague 8, Czech Republic*

⁴*State Key Lab. of Solidification Processing, Northwestern Polytechnical University,
710072, Xi'an, P.R. China*

*email: jakub.cizek@mff.cuni.cz

Nanostructured metals containing nano- and micro-cavities can be prepared by various methods. Morphology of cavities can be controlled by varying the parameters of preparation. This enables fabrication of nanostructured metals with properties tailored for particular applications, e.g. nanostructured metals containing fractal-like cavities with a wide size distribution are used as omnidirectional absorbers of light from the visible into the infrared spectral region. Positronium (Ps) is a non-destructive probe of nanoscopic cavities capable of precise determination of their size distribution. In conventional metals Ps does not form since any bound state of positron and electron is quickly destroyed by the screening of conduction electrons. However, a thermalized positron escaping from a metal through inner surface into a cavity may form Ps by picking an electron on the surface. This process was examined in the present work on nanostructured metals prepared three various methods: (i) thin films of black metals (Au and Al) evaporated in N₂ atmosphere; (ii) nano-porous bulk Pd prepared by electrochemical etching of PdCo alloy; (iii) nanostructured Gd prepared by selective evaporation of Mg from MgGd alloy. Our investigations confirmed that Ps was formed in nanostructured metals. The the size distribution of nano-pores in the samples has been determined. The mechanism of Ps formation in these samples is discussed in the paper.

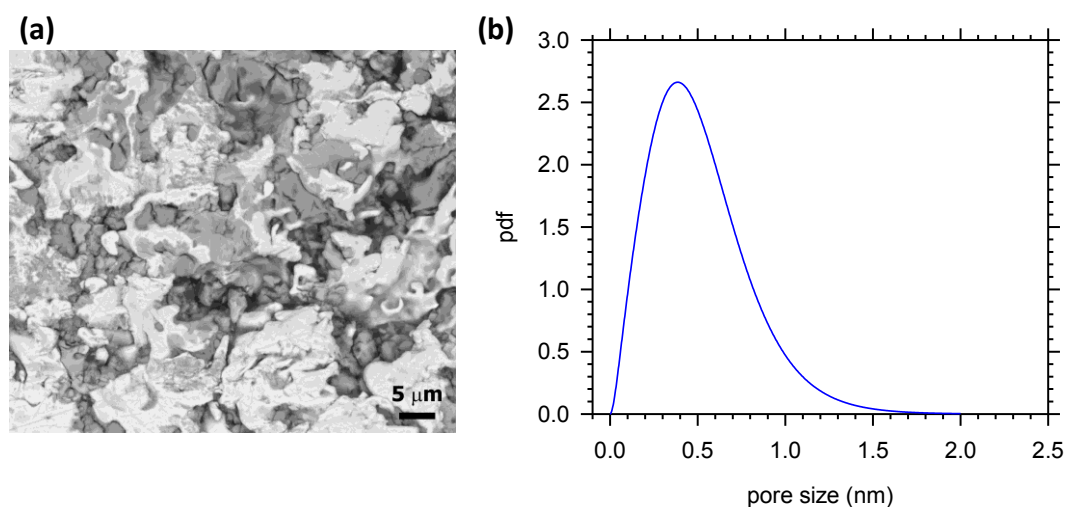


Fig.1. (a) SEM micrograph of nanostructured Gd prepared by selective evaporation of MgGd alloy; (b) size distribution of nanoscopic pores determined from pick-off annihilation lifetime of ortho-Ps.