Slow positron annihilation studies of black and reflective Al films prepared by magnetron sputtering

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In this work we present results of study of Al films prepared by pulsed DC magnetron sputtering: (i) smooth reflective Al films deposited in 0.5 Pa Ar atmosphere and (ii) rough black Al deposited in 0.5 Pa Ar + N_2 atmosphere. In case of reflective films the incident light is scattered into various angles. The total diffusion reflectance falls into range of 65 – 85 % depending on the film roughness and wavelength of the incident light. However in case of black films the incident light is absorbed in the film due to multiple light reflections from the surface resulting in a total diffusion reflectance 2 – 10 %.

AFM and TEM measurements revealed different structure of reflective and black Al films. Surface roughness of both types of films linearly increase with increasing film thickness. In reflective Al grains form compact film, while in black Al grains form porous moth-eye-like structure. The nano-porosity rather than the surface roughness is thus the key factor leading to the blackening of the films. In porous metals containing nano-cavities a thermalized positron may pick an electron on inner surface and escape into a cavity forming Ps. In reflective films Ps is formed only on the surface while in black films Ps is formed the whole volume. Applying the Tao-Eldrup model one can calculate that the mean size of nano-cavities is approximately 5 Å.

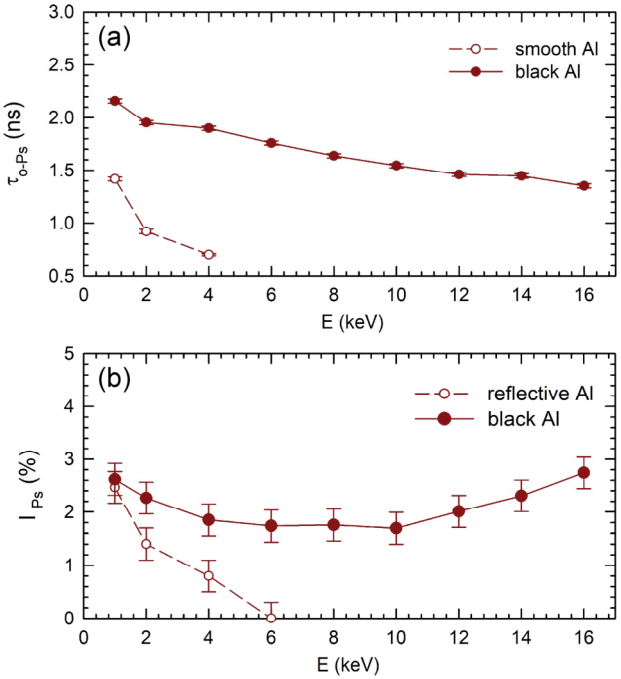

Figure 1 *o-Ps lifetime (a) and intensity (b) for reflective and black Al film with thickness 20 μm.*

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