

Transmission of X-rays through windows

Technical Note

The sensitivity of ESCA measurements is affected by the transmission of the X-ray window. The transmission of the window depends on its thickness and the material it is made of. Contamination of the window especially by heavy elements needs to be avoided. A layer of only 0.17 μm will decrease the transmission of the characteristic Mg X-rays by a factor of about two.

The transmission T is determined by the equation:

$$T = \left(\frac{I(d)}{I_0} \right) = e^{-\mu d}$$

$I(d)$ stands for the photon intensity at a given position and d for the window thickness. I_0 depicts the intensity, which will be achieved at the given position without using a window. The absorption coefficient μ is a complex function of the photon energy and depends strongly on the window material.

Fig. 1 shows the transmission T of an Al window as a function of the window thickness and the photon energy E . The transmission of an Al window with 5 μm thickness is 44% for Mg K_{α} X-rays (1253 eV) and 60% for Al K_{α} X-rays (1487 eV). Undesired low energy Bremsstrahlung and characteristic X-rays are sufficiently suppressed.

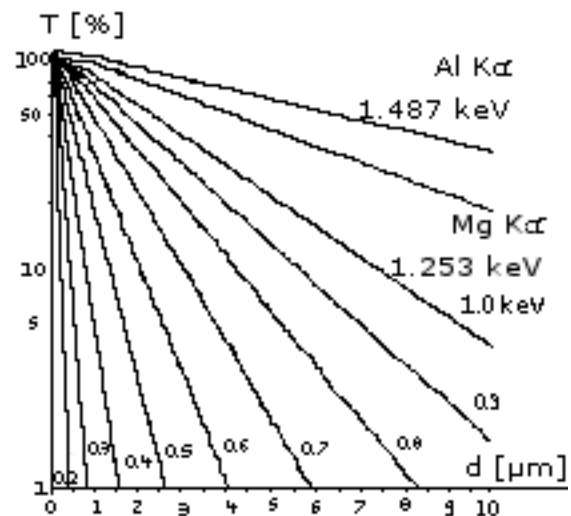


Figure 1: Transmission T of an Aluminum window for different photon energies as a function of the window thickness d .

d	Mg K _α	Al K _α
1 μm	85 %	90 %
2 μm	72 %	82 %
5 μm	44 %	60 %

Table 1: Transmission T of Aluminum windows with different thicknesses for Al K_α and Mg K_α radiation.

The transmission values given above go down considerably with contaminations of the window caused by evaporations from the X-ray cathode. A wolfram film of only 0.2 μm thickness will absorb the same amount of Mg K_α X-Rays as a 2.5 μm Al window. For this reason it is strongly recommended to check if the window needs to be changed by carefully seeing over the window. Furthermore, frequent sputtering of heavy elements in the analysis chamber is likely to cause a noticeable contamination of the window.

Higher transmissions may be achieved by using Mylar windows coated with a thin aluminum film of about 0.1 μm thickness. The transmission of the X-rays through an aluminized polymer window of 0.9 μm thickness is 88% for Al K_α radiation and 98% for Ag L_α radiation (see figure 2).

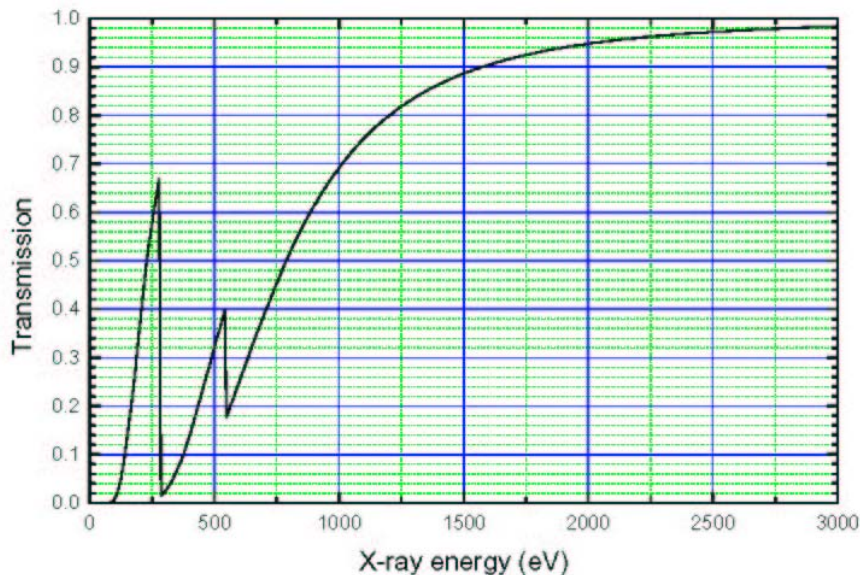


Figure 2: Transmission through a 0.9 μm thick Mylar window.

References:

[1] Publications of the Kaman Sciences Corporation "X-Ray Cross Section Compilation from 0.1 keV to 1 MeV", Volume 1, Revision 1, 1971.

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