Role of the electron Inelastic Mean Free Path in x-ray photoemission and x-ray absorption spectroscopy of solid copper

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The Inelastic Mean Free Path (IMFP) of electrons at low and intermediate kinetic energies plays a key role in determining the probing depth of various spectroscopic techniques based on the collection of photoemitted electrons (XPS, AEY, TEY ...) [1-2] and enters also directly in the interpretation of the x-ray absorption oscillations commonly referred to as X-ray Absorption Spectroscopy (XAS) [3]. While modern IMFP determinations and calculations are usually very accurate, there are discrepancies between the IMFP curves reproducing XAS data and those obtained by other techniques [4]. In this work we present a novel determination of the IMFP curve in solid copper obtained using the overlayer method and core photoemission spectroscopy using synchrotron radiation. In this context, new experimental procedures have been developed to improve the reliability of IMFP determinations from the overlayer method, discussing the role of elastic scattering [2]. Moreover, the IMFP curve is also determined by comparing ab-initio multiple-scattering simulations and experimental Cu K-edge data showing a very satisfactory agreement with the curve probed by photoemission, extended to a larger energy range. Detailed prescriptions on how the inclusion of the IMFP determination is realized in multiple-scattering simulations are reported. An experimental XANES analysis of the IMFP using the finite-difference-method proposed by Bourke and Chantler [4] has been also done, and found in reasonable agreement with the two above mentioned investigations. The resulting IMFP curve appears to be a solid result obtained combining three independent techniques which provides an accurate determination of IMFP in solid copper overcoming some previously observed discrepancies. The developed approach, validated in the case of crystalline copper, can be extended to the determination of the electron IMFP in thechonologically relevant materials [2].

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References

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