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Positronics of subnanometer atomistic imperfections as high-informative characterization tool in nanomaterials science

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Progress in nanomaterials science relies on high-informative characterization probes sensitive to length-scales of subnanometer range. One of such probes is grounded on space-time continuum determination for electron interaction with its antiparticle (positron). This phenomenon realized as positron annihilation lifetime spectroscopy (PALS), can be applied to study atomistic imperfections (free-volume defects) in solids despite their structural organization [1]. But when dealing with nanomaterials possessing nanostructural inhomogeneities, this method seems too ambiguous in view of complications in the adequate physical interpretation.

In this report, we analyze methodological resolutions for PALS applied to characterize different types of nanomaterials. The first part deals with time-dimension relations followed from correct application of positron-electron interaction formalism in case of *structurally homogeneous media*, such as those composing host matrices for nanoparticles. At the example of glassy arsenic sulfide substrates, we justified a sequent route employing canonical two-state positron trapping model. Critical overview was given in view to ignore these principles, speculatively underestimating free volumes responsible for positron trapping in chalcogenide type solids [2]. The second part concerns fundamentals of PALS applied to *nanoparticle-embedded inhomogeneous media*, such as (1) *organic-inorganic nanocomposites* like polyvinylpyrollidone suspension of mechano-chemically-milled arsenic sulfide, (2) *crystallization/ceramization-affected nanoinclusions* like "hot"- and "cold"-grown nanocrystallites in phase-separated glassy-like matrices and (3) *structurally-intrinsic nanoinhomogeneities* in network glass-formers in the form of different structural defects.

1. *Shpotyuk O., Filipecki J.* Free volume in vitreous chalcogenide semiconductors: possibilities of positron annihilation lifetime study, Ed. WSP, 2003.
2. *Kavetskyy T.* et al. // Solid State Ionics.-2013.- **233**.-P.107-109.