

P11 | **Nano-porosity of polymeric sorbents and membrane materials as seen by PALS and low temperature gas sorption**

V.P. Shantarovich^{1,*}, V.G. Bekeshev¹, I.B. Kevdina¹, Yu.P. Yampolskii², M.V. Bermeshev², and N.A. Belov²

¹*Semenov Institute of Chemical Physics RAS, Kosygin st.4, 119991 Moscow, Russia*

²*Topchiev Institute of Petrochemical Synthesis RAS, Leninskii Prosp. 29, 119991 Moscow, Russia*

*email: shant@center.chph.ras.ru

Positron annihilation lifetime spectroscopy (PALS) is a recognized method for the studies of nano-porosity (size distributions of nano-pores) in solids. However, to our knowledge, until recently [1], no special attempts were made to estimate the limits of application of this method to the study of elementary free volumes (EFV). The reason is that, in fact, no alternative methods, applied to the same problem, were discussed. Meanwhile, the studies of nano-porosity are extremely important for creation of novel polymer membrane materials and sorbents with the unique permeation (above 10^3 Barrer for O₂), specific surface (about 10^3 m²/g) and selectivity. The materials are used in solving the problems of ecology, chemistry and medicine. One of contemporary methods, which can be, in some extent, an alternative to PALS, is the low temperature gas sorption (LTGS). In this report, we discuss results of several investigations of polymer membrane materials and sorbents, where the both PALS and LTGS methods are used. Our conclusions on the ranges of application of the two methods are summarised in Table 1 according to pore size (micro-pore or nano-pore) and condition of the material (ready made membrane or powder).

Table 1. Adequacy of PALS and LTGS methods for the studies of porous polymer materials

State of material \ Pore size	Micro-pore <2 nm	Meso-pore 2-50 nm
	Powder	(1) PALS, LTGS (<i>HK</i>)
Membrane	(2) PALS	(4) LTGS (<i>BJH</i>), Sc-CO ₂

HK and *BJH* in brackets indicate Horwath-Kawazoe and Barrett-Joyner-Halenda methods used to analyze low-temperature gas (N₂) sorption (LTGS) curves. Inscription Sc-CO₂ for membrane meso-pore (4) means sorption experiments on creation of meso-porosity in polymers swelled by CO₂ in super-critical (Sc) state. Application of the two methods for EFV studies are determined by different conditions. For example, for PALS, the crucial point is concentration of the trapping centers (10^{18} - 10^{20} g⁻¹), which has to be enough to localize Ps atom before annihilation. For LTGS, materials have to be only in the powder state.

Thus, both methods supplement each other in the research.

[1] V.P. Shantarovich, V.G. Bekeshev, N.A. Belov, *et.al.* High Energy Chem. 50, 300 (2016).