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What we Learn from Positron Annihilation Spectroscopy on Energy Materials such as Proton Exchange Membranes

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In the research on energy materials the positron is applied as a highly mobile probe for the detection of vacancy-like defects and their chemical surrounding in a non-destructive way. (Coincidence) Doppler broadening spectroscopy ((C)DBS) of the positron annihilation line is used to investigate defect distributions or the identification of vacancies, e.g. in electrode materials in order to understand how structural and Li vacancies affect parameters such as capacity, rate capability, and aging [1]. Positron annihilation lifetime spectroscopy (PALS) provides a powerful technique for characterizing the free volume and, more specifically, the mean pore size in polymers.
We performed PALS measurements on proton exchange membranes (PEMs) at different humidity in order to study the change of the free volume and the pore size distribution [2,3]. Such PEMs are used in fuel cells in which the humidity control and water management is high importance to improve the fuel cell efficiency. A slight decrease in the free volume was found up to a relative humidity of 30% whereas it increases strongly for a relative humidity of more than 30%. The volume of the voids doubles from 0.036 to 0.078nm3 by changing the relative humidity from 30 to 80% [3]. In this contribution, I will give a brief overview of positron applications on different materials relevant for energy research, focusing specifically on measurements on PEMs.

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