CHARACTERIZATION OF NANOPOROUS CERAMIC MATERIALS USING COMBINED XRD, XPS AND PAL SPECTROSCOPY

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Abstract Some functional nanoporous materials such as dielectric magnesium aluminate $MgAl_2O_4$ ceramics with spinel structure are widely used for environment humidity sensors. It is established that functionality of these humidity-sensitive ceramics depends on their microstructural peculiarities concerning mainly of phase composition. This work is aimed to investigate a microstructure of sintered nanoporous magnesium aluminate materials using combined X-ray diffractometry (XRD), high-resolution X-ray photoelectron spectroscopy (XPS) and positron annihilation (PAL) methods.

The studied ceramics were sintered in a special regime with maximal temperatures from 1,100°C to 1,400°C during 2 h. The initial powders of Al_2O_3 and MgO were used as starting components within conventional ceramics technology route.

The XRD results showed that ceramics sintered at 1,100–1,200°C contained mainly the spinel phase and additional MgO and Al_2O_3 phases. In contrast, the ceramics sintered at 1,300–1,400°C contained only the MgO phase. These conclusions agree well with XPS data, where a core-level O 1s spectrum deconvoluting on two independent peaks corresponds to main spinel and additional phases (MgO and/or Al_2O_3).

The PAL results showed that more perfect ceramic microstructure representing mainly in small amount of additional phases reflects more considerable changes in the positron trapping parameters such as mean and defect-free bulk positron lifetimes.

Thus, the combined using of XPS, XRD and PAL spectroscopy is a quite informative tool to study phase interactions in nanoporous spinel-type ceramic materials caused by their technological modification owing to sintering temperature.

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