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Grzegorz Zuzel (Jagiellonian U. in Krakow): Low-background techniques in direct dark matter searches

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In many experiments searching for rare nuclear processes, like direct interactions of cold dark matter particles, an extremely low radioactive contamination level of the detector target and the surrounding materials has to be achieved. This is only possible after implementation of an extensive R&D program and careful material screening with appropriate devices. Selected ultra-sensitive instruments and the most relevant experimental techniques allowing for searches and development of ultra-radio pure materials will be discussed. This includes ICP-MS studies, gamma-ray spectroscopy, large-surface alpha spectroscopy, counting of Rn-222 and Rn-220 down to single atoms, purification of gases and studies of surface cleaning procedures. Application of the mentioned (complementary) techniques makes it possible to study the entire decay chains what is important for samples which in the production process undergo some chemical treatments resulting in disequilibrium in the chain (enrichment/depletion of some elements). For example, in the U-238 chain ICP-MS allows to study the long-lived U/Th isotopes, gamma-ray spectroscopy (or Rn-222 emanation) provides information about Ra-226 and the short lived Rn-222 daughters, and the large-surface alpha spectroscopy may be applied to investigate the bottom part of the chain, namely Po-210 (and indirectly Pb-210). Po-210 is of special interest since as an alpha emitter it may be a direct (e.g. degraded alphas) or indirect source of background (neutrons produced in the alpha-n reactions). Application of the outlined methods and results, with emphasis on high-sensitivity Rn emanation studies, on the development of etching methods effectively removing surface Po-210 contamination and on the first measurements of Po-210 content in the (oxygen-free) copper, stainless steel and titanium samples, will be presented.

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