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United role of radon decay products and nano-aerosols in radon dosimetry

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The major part of human exposure to natural radiation originates from inhalation of radon (Rn) and radon short-lived decay products (RnDP: ^{218}Po, ^{214}Pb, ^{214}Bi and ^{214}Po). RnDP are formed as a result of α-transformation of radon. In the beginning they are positive ions which neutralize and form clusters with air molecules, and later partly attach to background aerosol particles in indoor air. Eventually, they appear as radioactive nano-aerosols with a bimodal size distribution in ranges of 1–10 nm (unattached RnDP) and of 200–800 nm (attached RnDP). When inhaled, they are deposited in the respiratory tract. Deposition is more efficient for smaller particles. Therefore, the fraction (f_{un}) of the unattached RnDP, which appears to be influenced by the number concentration and size distribution of general (background) aerosols in the ambient air, has a crucial role in radon dosimetry.

Radon, radon decay products and general aerosols have been monitored simultaneously in the kitchen of a typical rural house under real living conditions, also comprising four human activities generating particular matter: cooking and baking, as two typical activities in kitchen, and cigarette smoking and candle burning. In periods without any human activity, the total number concentration of general aerosol ranged from 1000 to 3000 cm^{-3},with the geometric mean of particle diameter in the range of 60–68 nm and with 0.1–1 % of particles smaller than 10 nm. Preparation of coffee changed the concentration to 193,000 cm^{-3}, the geometric mean of diameter to 20 nm and fraction of particles smaller than 10 nm to 11 %. The respective changes were for baking cake: 503,000 cm^{-3}, 17 nm and 19 %, for smoking:423,000 cm^{-3}, 83 nm and 0.4 %, and forcandle burning: 945,000 cm^{-3}, 8 nm and 85 %.

While, as expected, a reduction of f_{un} was observed during cooking, baking and smoking, when larger particles were emitted, f_{un} did not increase during candle burning with mostly particles smaller than 10 nm produced. Because the processes of RnDP creation by radioactive transformation, their neutralization, clustering and association with aerosol particles need time, the response of f_{un} on the changes in general aerosol is delayed in time and therefore f_{un} response on the fast changes, such as those caused by short human activities, may be obscured and even not observed.