Nanoparticles in products from fossil fuel combustion

[a]Ribeiro J, [b,c]Silva L F O, [a,d]Flores D

The generation of anthropogenic carbonaceous matter and mixed crystalline/amorphous mineral nanoparticles in the 1 to 100 nm size range by worldwide coal power plants represents serious environmental problems due to their potential hazards. The characterization of nanoparticles from coal combustion offers extraordinary opportunities in analytical procedures and may provide some direction for green applications or green design, especially carbon-based nanoparticles. In this context, carbon multi-walled nanotubes and fullerenes (C60, C70, C80) are of great toxicological interest because during coal combustion inhalable particles might be set free.

The physico-chemical characterization of nanoparticles present in products from coal combustion and their interaction with environment are the aim of this study. The methodologies applied for this work were: Raman spectroscopy, high-resolution transmission electron microscopy with energy dispersive X-ray spectroscopy (HR-TEM/EDS) and field emission scanning electron microscopy with energy dispersive X-ray spectroscopy (FE-SEM/EDS).

The results demonstrate that the fly ash samples are composed of, among others, ultrafine size (≈ 100nm) glassy spheres, carbonaceous nanospheres (< 50nm) containing trace elements such as As, Hg, Pb, Se, and nanoparticles with multiple nanominerals assemblages. Both HR-TEM and FE-SEM/EDS analyses also reveals the presence of ultrafine quartz, either embedded in amorphous phases or as discrete nanoparticles, mullite as ultrafine crystals embedded in the Al-Si matrix of the amorphous phases, maghemite, hematite and magnetite as breakdown products of Fe-sulphides and Fe-sulphates, and minor minerals phases with anhydrite, rutile, anatase, barite, and kaolinite.

The studies performed on materials from spontaneous coal combustion revealed the presence of carbon nanoparticles, agglomerates and mineral phases. The carbon nanoparticles included fullerenes and multi-walled carbon nanotubes containing some potentially hazardous elements with varying degrees of crystallinity. Mineral nanoparticles include several crystalline components such as pickeringite, hematite, mullite, anhydrite, arcanite, and salammoniac.

[a] *Centro de Geologia da Universidade do Porto, Portugal (joanaribeiro@fc.up.pt)*
[b] *Instituto de Pesquisas Ambientais e Desenvolvimento Humano, IPADHC, Capivari de Baixo, Santa Catarina, Brasil.*
[c] *Centro Universitário Univates, Programa de Pós-graduação em Ambiente e Desenvolvimento, Lajeado, Brasil.*
[d] *Departmento de Geociências, Ambiente e Ordenamento do Território, Faculdade de Ciências, Universidade do Porto.*