Cesium-rich micro-particles unveil the explosive events in the Fukushima Daiichi Nuclear Power Plant

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Cesium-rich micro-particles (CsMPs) retain novel information on the molten core-concrete interaction (MCCI) that happened inside the Fukushima Daiichi Nuclear Power Plant (FDNPP). In order to elucidate the micron-scale processes of radionuclides release during the explosion, systematic micro-analyses were completed on the CsMP using a variety of electron microscopy techniques.

CsMPs specimens were discovered from paddy soils in Okuma town and in atmospheric particulates collected at Suginami, Tokyo, by using autoradiography and SEM. Subsequent to gamma radioactivity measurement The CsMP was thinned by using a focused ion beam system. STEM was employed for nano-scale analysis.

The size, ^{134}Cs and ^{137}Cs radioactivities were determined to be 0.58-5.3 μm, 0.273-145 Bq, 0.207-134 Bq, respectively. All CsMPs were mainly composed of Si oxide associated with Fe, Cs, Zn, Sn, Rb, K, Mn, Cl and Pb. The Cs concentration ranges from 0.81-36 wt% as Cs_2O. The electron diffraction pattern revealed diffused diffraction maxima, indicating the amorphous structure. Various nanoparticles were identified at the size of 2-40 nm; crystalline $Ag_2Se_{0.5}S_{0.5}$, silver telluride and Sn metal nanoparticles, indicating that a part of volatile fission products such as Te and Se associated with Ag to form airborne nanoparticles. Numerous pores were present in the center, which is the evidence of entrapped CO_2 and H_2O sparged during MCCI. Surface and interior of the CsMPs exhibited unique texture of nanoparticles aggregation. Hence, condensation of SiO(g) proceeded by the immediate incorporation of soluble Cs already present as vapors and entrapment of airborne nanoparticles liberated from the debris as the particle grew. Still, the CsMP is another important route of dispersion of the low-volatile radionuclides to the surrounding environment.