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Characterisation of aerosols formed in high temperature experiments

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Aerosols were formed in two QUENCH experiments (No. 10 and 11) performed in the Forschungszentrum Karlsruhe (Steinbrück et al., 2006) in frame of the LACOMERA project to simulate the main phases of a spent fuel pool accident. Twenty fuel rod simulators were heated by 6 mm diameter tungsten heaters installed in the rod centre and surrounded by annular ZrO_2 pellets to simulate fuel pellets. QUENCH-10 had the following steps: pre-oxidation in steam, air ingress period and final water quenching. In QUENCH-11 the water-filled bundle was boiled-off and subsequently flooded with a low water injection rate from the bottom.

Aerosols were collected by means of an integral collector (Ni plate with a pocket attached to its bottom) and by ten-stages impactor systems (Hózer, Z. et al., 2003), working in the most important steps of the experiments. The maximum temperature at aerosol sampling was 1632 ^{o}C in QUENCH-10 and 2024 ^{o}C in QUENCH-11. Mass change of the impactor plates and the Ni collector was measured. Morphological features (shape and size) were studied by SEM (Pintér-Csordás et al., 2000). EDX was applied for elemental analysis of aerosol particles and aggregates, while mass spectrometry (spark source and laser ionisation) was used for the chemical analysis of the aerosol settled on the quartz fibre filters (part of the impactor systems) and on the Ni plate.

Aerosol particles and aggregates were settled on each impactor plate, however the coverage of them was different and it was in correlation with the mass change of the collector plates. The amount of the collected aerosol was 5 % higher for QUENCH-10 than for QUENCH-11 and the weight of the powder settled in the pocket was ten times more in QUENCH-10. The highest amounts of aerosol and therefore the highest mass change were found for samples taken at the cooling stages of the experiments. The size of the individual aerosol particles was between a few tenth of μm and a few μm by SEM. Figure 1 shows two SEM images taken for the Ni plates.

In the aerosols of QUENCH-10 Zr, Sn and the elements of the steel components and some impurities were found. In the aerosols of the QUENCH-11 experiment, mostly W, Ta and Mo, further elements of the steel components and some impurities were detected. These elements were originated from some structural materials such as heating rod, case of the thermometers, etc. Ten times more Zr was detected by SSMS in the pocket used in QUENCH-10 than in QUENCH-11. This can be due to the larger degree of cladding oxidation in QUENCH-10. In QUENCH-11 oxidation of the heating rods and some structural materials were more pronounced, therefore W, Mo, Sn and steel components were detected on the Ni plate by LIMS. All these results together with the data collected during the two experiments will be used for later model calculations.

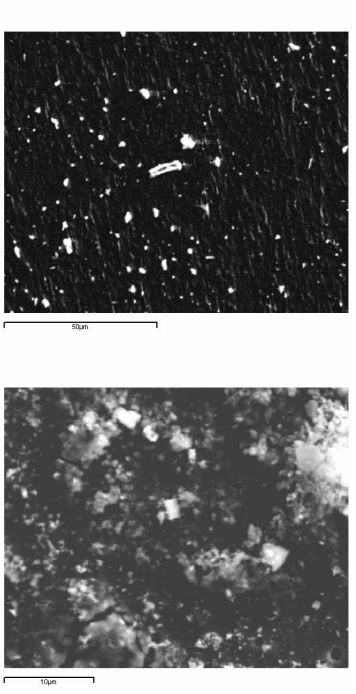

Figure 1. SEM images of the Ni plates applied in QUENC10- and -11, respectively.

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Hózer, Z. et al. (2003). *Nuclear Technology*, 141, 244-256.

Pintér-Csordás, A. et al. (2000). *Journal of Nuclear Materials*, 282, 205-215.