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Neutron Radiography Investigations to Study Material Behaviour in Loss of Coolant Nuclear Accidents

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Neutron radiography is used to study safety related material processes occurring in design basis loss of coolant accidents (LOCA) and severe accidents (accidents beyond LOCA). The investigations comprises in-situ and ex-situ experiments to study the hydrogen uptake of zirconium alloys used as fuel rod cladding material and the redistribution of absorber materials in damaged control rods.

The in-situ investigations have shown that the hydrogen uptake occurs rapidly during the first seconds. Later, the hydrogen concentration in the materials decreases slowly. Also hydrogen diffusion in zirconium alloys were studied in-situ.

As example for the ex-situ investigations the hydrogen distribution in specimens prepared from LOCA simulation test were shown. Hydrogen bands close to the burst cracks were found. They are oriented non-symmetrically to the cladding tube axis.

During severe accidents control rods are damaged by the eutectic interaction between cladding tube (SS) and guide tube (zirconium alloy). The contact between both tubes results in local melting the molten absorber material (AgInCd) flows out of this molten spot and is redistributed.

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