Contribution ID: **129** Type: **Poster**

Structural Transformations in Metallic Iron under the Action of External Irradiation

Wednesday 19 September 2012 18:00 (1h 50m)

Using several modes of Mossbauer spectroscopy, after effects have been studied of irradiating metallic iron with 1) thermal neutrons (fluence of 1.8·E24 n·m-2); 2) protons (energy, 6.0/2.0 MeV; fluence, 1.0·E22 p·m-2); 3) deuterons (energy, 9.0/7.3 MeV; fluence, 1.0·E21 to 1.0·E22 d·m-2); 4) α-particles from a 238Pu source (energy, 5.5. MeV; fluence, 2.5·E19 α·m-2); 5) 12C- and 14N-ions (energy, 47.2/0 and 58.8/0 MeV, respectively; fluence, (1.6 to 8.2)·E19 ions·m-2); 6) 6.1 to 8.8 MeV α-particles and 208,212Pb, 212,216Po recoil nuclei from a 228Th-source (energy, 0.11 to 0.17 MeV), the total fluence being 4.5·E18 particles·m-2.

The experimental data obtained in the study enabled various types of external radiation to be correlated as to their radiation damage, the effect on the structure-, phase composition- and corrosion resistance properties of metallic iron.

After irradiating with neutrons, protons and weak deuterons (beam currents of less than 5 μA), it is only the magnetic superfine structure, which is characteristic of alpha-Fe, that has been observed in the experimental spectra.

Irradiation with intensive beams of deuterons (beam currents, 10 to 15 μA), α-particles , 12C- and 14N-ions leads to a structural disordering of the alpha-Fe lattice and to the emergence of the gamma-phase on the surface of foils and in the near-surface area: a single component, which is 2 to 3 times wider as compared to the magnetic sextet lines: is a result of local heating of the lattice to high temperatures with subsequent recrystallization from the "molted" volume.

Irradiation of iron foils with recoil nuclei (combined with α-particles) provokes corrosion processes and is accompanied by an intensive oxidation of the metal.

The work was supported by a grant from the Russian Foundation for Basic Research (12-08-00048).

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Session Classification: Poster Session

Track Classification: Radioactive elements in the environment, radiation archeometry and Health Physics