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Hyperfine Interactions in Pd foils during D/H electrochemical loading

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The study of the Fleischmann and Pons Effect (FPE) i.e. the excess power production during electrochemical loading of deuterium in palladium has a multidisciplinary character. Correlations between the material status and the occurrence of the effect as well as some changing of the electrochemical interface status have been observed. During the last two decades the phenomenon was observed, well above the measurement uncertainties, in several calorimetric experiments. The lack of reproducibility has been so far responsible for the absence of a clear explanation of the phenomenon but measurement chains have been conceived to enhance the spectrum of information required to define the effect. Recently a specific study was carried out that discovered Radio Frequency emission during the occurrence of excess power. Such observations and interrogations are motivating studies of working cells, but atomic scale probes are desirable. In this work we used the local probe nuclear technique of Perturbed Angular Correlations (PAC). The probe nucleus ^{181}Hf (^{181}Ta) was implanted into four Pd samples at 80 keV. After recovery of implantation defects by vacuum annealing at 550 °C, the PAC measurements were carried out during loading of D (D_2O) or H (H_2O) as a function of applied current and voltage. The spectra clearly evidenced the diffusion and distribution of foreign (H, D) atoms, during loading expressed by the observation of three different EFG distributions – a static like distribution of EFG probably due to an equilibrium concentration of D atoms, - a dynamic distribution probably due to out-of equilibrium diffusion of D atoms, and a specific EFG that is due to the occurrence of a regular charge distribution in the surroundings of the probing Ta atom. This might be due to a temporary coherent distribution of D atoms inside the Pd lattice, that makes a regular charge distribution in the neighbourhood of about 10% - 15% of the Hf/Ta probe atoms. This last EFG is only observed on some spectra during some loading periods. Contrarily, only the static and dynamic “states” were observed during the H loading.

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