Report of discussion on H isotope retention

Dr. M. Mayer presented some general considerations on PMI-modelling and comparison to experiment. TDSmeasurements yield only a convolution of activation energies, pre-exponential factors and concentration profiles, a simple assignment of peak positions and activiations energies is usually not possible but requires modelling. Isotope exchange data indicate that filled 'trap sites' are not passive: This reaction mechanism is missing in standard trap-diffusion models. Long-term (months) hydrogen loss at room-temperature is hard to reconcile with TDS data, but might be connected with isotope exchange. He emphasized the importance of tight connection of experimental and modeling works.

Prof. Y. Hatano addressed main problems to understand H isotope retention in irradiated W under fusion conditions. He pointed out that majority of data available in published literature is D retention in W irradiated at around room temperature in vacuum or He atmosphere without the presence of hydrogen. He stated that kinetics of microstructure development under irradiation should be sensitively dependent on irradiation temperature and H-defect interactions, and it is important to perform irradiation tests at elevated temperatures under the presence of H isotopes (and He). Prof. Y. Hatano emphasized that understanding of long-range diffusion under strong trapping effects and temperature gradient is necessary for the evaluation of H isotope retention in damaged W. He indicated that there is no data on heat of transport of H isotope in W. Because of difficulties in experimental evaluation of this parameter, Prof. Y. Hatano asked contributions of modeling community on this point. He commented it is necessary to develop diffusion code in which trap density and binding energy are variable with time and temperature for accurate simulation of thermal desorption spectra.

Prof. G.-H. Lu pointed out that analysis of thermal desorption spectra is a good tool to connect experimental and modeling works. Dr. M. Mayer mentioned that TDS could be used but assignment of peaks directly to traps is not solely sufficient. Dr. C. Zhang stated that good understanding of microstructure is necessary as a bridge between experimental data and modeling.

Dr. C. Zhang possessed discussion on similarity/difference in H isotope loading by plasma, atom and gas exposure. Dr. P. Pelicon mentioned there are various methods to introduce hydrogen and defects from various sources at various depths in materials in bulk scale: plasma, ion-beams, electrons, etc. Prof. Y. Hatano commented that plasma could be the most relevant to fusion reactor conditions but can introduce difficulties in TDS interpretation because of formation of blisters and bubbles with hydrogen. He also mentioned one could introduce H in more controlled way by using gas and atoms. Dr. Y. Gasparyan pointed that, in contrast to gas exposure at high temperatures, H isotope atoms allow low temperature loading without significant modifications of irradiation-induced microstructure by heating.

Dr. M. Shimada questioned about database on vacancy cluster migration energy. Prof. A. Hasegawa stated there are experimental data for several types of defects but not sufficient. Prof. G. –H. Lu mentioned that MD can give you migration energies of vacancy clusters and its connection on rate theory. Dr. M. Shimada also pointed out the question of how deep in the bulk one needs to go for simulating conditions in high-dpa environments.

Dr. M. Mayer pointed out the amount of He production in W by transmutation is very low. Prof. Y. Hatano stated that the presence of relatively high concentration of tritium in W can yield lots of He-3 production over several years. He also stated that the effects of He/H from plasma on surface/subsurface are important. Dr. C. Grisolia mentioned that impurities of oxygen in machine should be accounted in context of the surface and sub-surface conditions (equally important to the consideration of He).