Influence of molecules on outer layers of JET plasma – spectroscopic study

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In the fusion plasma reactors most of the plasma is contained in the hot core. Nevertheless, there is a cold outer layer of plasma in the vicinity of the walls, which is crucial to the survival of the plasma vessel and therefore the reactor itself. This layer is cold enough to have a significant molecular component, and its understanding must include the study of creation and destruction of different molecules. Chemical erosion by hydride creation is an important component of the wall erosion, hydrogen fuelling and nitrogen seeding introduce large amount of molecules, which dissociate and are recreated by interaction with the vessel walls. Stable molecules created in this layer may help the tritium fuel to escape the plasma vessel and contaminate the pumps or even escape entirely. Last but not least, the plasma edge has a strong impact on the overall plasma thermal confinement (and thus, on fusion power) which is not yet understood, though the codes can reproduce correctly the core plasma state if a proper plasma edge condition is put in. There is a significant probability that correctly described molecular dynamics will help to understand this dependence.

Determination of the density and internal state of molecules present in the plasma is most often being done by optical emission spectroscopy, because of its simplicity of use. We present the results of the molecular spectroscopy analysis of spectra of the dominant hydrogen (and its isotopes) containing molecules present in outer layers of the plasma. We show the molecular dynamics of hydrogen, influence of seeding on chemical erosion of the walls deducted from hydrides molecular radiation, and its connection with the changes in local ELM dynamics. We also compare the experimental results with the current results of plasma modelling, providing information about the validity of the modelling codes and improving our understanding of the physical processes within this important plasma region.

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