§9. The Study on Vibrationally Excited Hydrogen Molecules with Be, C, W-walls by Low Energy Electron Impacts

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Beryllium (Be), carbon (C), and tungsten (W) have been recently proposed as a cover material around diverter in large-scale fusion reactor. Since these wall materials contact directly with the edge-plasma, the research on the interaction of the low temperature plasma with the surface becomes important. In addition, low-energy electrons and a considerable amount of vibrationally excited hydrogen molecules exist around the diverter. The investigations on the collisional processes of the low energy electrons with the vibrationally excited hydrogen molecules around metal surfaces are also important to understand the behaviour of low temperature plasma. In order to investigate those effects, our project has been focused on; 1) electron interactions with the solid surfaces, 2) electron scattering by H_2 heated on the solid surfaces.

Schilling and Webb[1)] measured the elastic scattering of electrons from Liquid Hg between 100 and 500 eV and for scattering angles between 60^o to 170^o. These measurements showed the scattering remarkably similar to that from Hg vapour and a model calculation also showed the differences between the liquid and vapour scattering were due to multiple scattering and inelastic processes. In addition their analyses show that i) higher-order multiple scattering are strongly attenuated by inelastic processes, ii) approximately half the observed integrated intensity has been scattered only once, iii) for backward angles, the atomic scattering factor is essentially the same for the atoms in the liquid and the vapour phases, and iv) attenuation coefficients for elastic electrons are of the order of several tenths of a reciprocal angstrom.

As a first trial, we have performed electron scattering measurements from an Au surface at 500, 1000, and 1500 eV. The clean surface is prepared by evaporating Au which was found to be particularly easy, which is neither the case of W nor Mo due to very high evaporation temperatures. Fig. 1 shows the relative intensities of elastically scattered electrons from Au surface. Dots and dashed lines are present results from Au surface and model calculations for an Au atom, respectively. As shown in Fig.1, similar undulations for both the experimental results and the model calculations in relative intensities have been clearly observed due to the atomic scattering factor at each impact energy. The depth differences of the undulation between the surface and atom were considered due to the multiple scattering effects, same as the results for Hg liquid experiment[1)]. Meanwhile, we have started calculations on the angular differential cross sections of W atoms in the energy range of 30 – 2000 eV using an independent atom model[2)] and extended to the same experiment for W surfaces. The results of these measurements are expected to give a better understanding of the processes in low temperature plasma with W surface around the diverter walls.

Recently, Hall et al.[3)] report the observation on recombinative desorption of atomic hydrogen on hydrogen-covered metal surfaces. The H^- produced by the attachment processes, $e + H_2 (v) \rightarrow H^- + H$, were observed as the function of electrons impact energy. The vibrationally excited H_2 (v) were produced from the interaction with heating metals of W and tantalum (Ta). These experiments show the vibrational populations near 3000 K up to v = 3 and for higher vibrational levels, well in excess of this temperature, with a maximum at v = 9.

We also have been preparing the electron scattering experiment with vibrationally excited hydrogen molecules produced around hearing metal surfaces such as the W and Ta. The experimental results of both the electron-surface interactions above descriptions and electron-vibrationally excited molecules collisions will hopefully show evidence to understand the fundamental phenomena in low temperature plasma near the diverter wall.

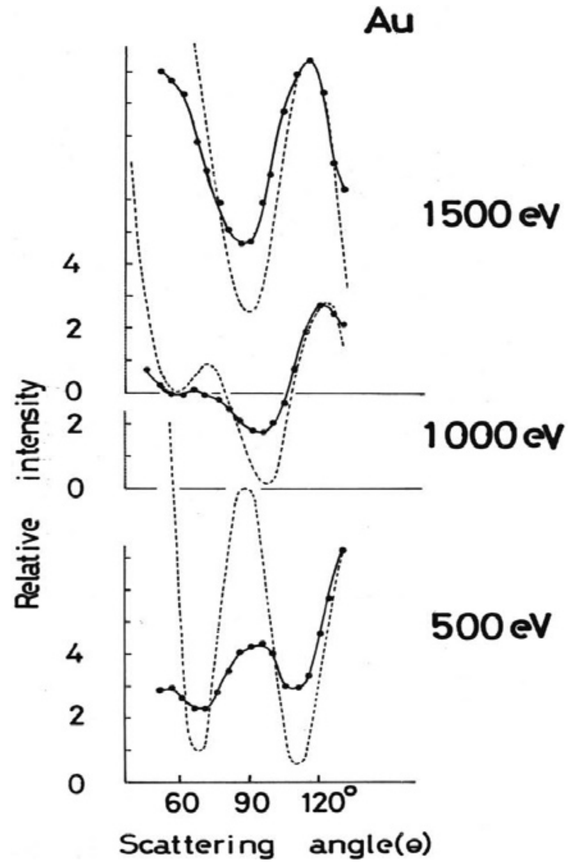

Fig.1. Relative intensities of scattered electrons from Au surface as a function of the scattering angle at 500, 1000, and 1500 eV.

1) Schilling, J.S. and Webb, M. B.: Phys. Rev. B **2** (1970) 1665
2) Blanco, F and Garcia, G: Phys. Lett. A **317** (2003) 458 and Phys. Lett. A **330**, 230 (2004).
3) Hall, R. I et al.: Phys. Rev. Lett. **60** (1988) 337