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Measurement of the adsorption isotherms and the mean residence time of hydrogen and deuterium physisorbed on a cold copper surface

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Cryopumping is one of effective methods to evacuate H_2 and has been used in various vacuum systems because of its cleanliness and high pumping speed. For development and utilization of cryopumps, it is indispensable to elucidate the physisorption characteristics of a cryosurface against H_2 in extremely high vacuum (XHV), where H_2 is the dominant residual gas. Several authors have reported unexpected outcomes in either the static or dynamic characteristics of H_2 cryopumping, such as the abnormal temperature dependence of the equilibrium pressure [1,2,3] and the deviation from the Dubinin-Radushkevich-Kaganer (DRK) equation [4,5], but their origins have not been clarified yet.
In this study, we aimed to obtain the adsorption isotherms and the mean residence time of H_2 and D_2 on a copper surface using the electron stimulated desorption (ESD) technique [6]. Since H^+ (D^+) ions are mainly generated by dissociative ionization of H_2 (D_2), the ESD yield of H^+ (D^+) is assumed to be proportional to the density of H_2 (D_2) physisorbed on the surface in the submonolayer range. We measured the adsorption isotherms at the equilibrium pressures between 10^{-10} and 10^{-6} Pa in the temperature range of 4.0 - 7.0 K and clearly observed the two-dimensional condensation. Whereas the adsorption isotherms of H_2 at pressures below 10^{-8} Pa were affected by H^+ originating from surface impurities of hydrocarbons, those of D_2 were able to be obtained without their influences in the whole pressure range. We also measured the mean residence time by monitoring the ESD yields of H_2 and D_2 in transitional states.

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