Surface chemical reaction between adsorbed molecules and substrates at 20K

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The dynamic chemical-reaction between the neutral gas and semiconductor surfaces held at 20K had been accidently discovered during the study of the surface band bending induced by oxygen molecules at 20K. It has been turned out that both the non-equilibrium band flattening and the violent chemical reaction are induced by illumination of the soft x-ray originated from the photoemission spectroscopy. We have systematically varied the parameters such as condensed molecules, substrates and photons in order to idenfify the fundamental mechanism of this non-thermal chemical reaction. With the information of the molecular orbital and the local electronic states of scanning tunneling microscopy, the dissociation of molecular species at the interface is enhanced by the local hybridation between the substrate and the gas molecules. This is confirmed by the slower initial reaction of N_2O than O_2 and O_2-dissociation induced by 1.97eV - photons. But the dissociation by way of antibonding state is not posible in the gas phase excitation due to 1.97eV-photons. On the other hand the extended reaction beyond the monolayer slows down compared to the first layer. In addition to the fundamental mechanism, it will be suggested how to use this novel reaction in the application of semiconductor processing.