

Ambient Pressure Scanning Tunneling Microscopy; Revealing Chemical Complexities under Heterogeneous Catalysis

Jeong Young Park^{1,2}, Won Hui Doh¹, Jeongjin Kim¹

¹Center for Nanomaterials and Chemical Reactions, Institute for Basic Science (IBS), Daejeon 305-701, South Korea

²Graduate School of EEWS and Department of Chemistry, Korea Advanced Institute of Science and Technology (KAIST), Daejeon 305-701, South Korea

Email: jeongypark@kaist.ac.kr

The modern surface characterization techniques have been discovered the surface phenomena of bimetallic materials such as selective segregation of elements, correlations of d-band centre shift and chemical reaction activity, and elemental compositions on each surface layer in ultra-high vacuum (UHV) condition. However, the industrial chemical reactions operate under high pressure in reactor that makes the difference of surface potential energy around 0.7 eV between UHV and atmospheric pressure. Therefore, the surface characterization methodology under more realistic environments is required to observe for understanding fundamental features at the molecular level [1].

In this talk, we present in-situ observation results of structural modulation on Pt-Ni metastable and Ni (111) surfaces at 0.1 Torr pressure of CO, O₂, and CO oxidation conditions with ambient-pressure scanning tunneling microscopy (AP-STM).[2] We show that the stable Pt-skin covered Pt₃Ni(111) surface is broken by segregation of dissociative oxygen-induced Ni oxides under elevated oxygen pressure environment, which evolved clusters could have a crucial relation with enhanced catalytic activity. While Ni single crystal surface exhibits the irreversible oxidation with the increase of oxygen exposure that leads to a formation of NiO multilayers [3], in case of PtNi alloy, NiO_{1-x}/Pt-Ni nanostructures would provide more efficient reaction path for CO oxidation at interface of specified oxygen deficient Ni oxide sites on the Pt₃Ni(111) surface because the modified electronic structure of Pt-Ni bimetallic surface layers not only prevents the CO deactivation, but also it provides more improved O₂ dissociation process by d-band center shift. The catalytic activity of Pt₃Ni(111) surface was significantly higher than those of Pt or Ni surfaces, which confirms our conclusion [4].

REFERENCES:

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