From ideal to real handling of clusters to acquire practical functionality

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It has been reported that uni-sized Pt clusters are fixed to an Si substrate as Pt cluster disks by impact of size-selected Pt cluster ions onto the substrate surface:[1] cluster impact.[2] This material possesses electrons accumulated at the sub-nano interface between the Pt cluster disk and the Si surface,[3,4] which enable catalytic NO reduction[5] and CO oxidation[6-8] at low temperatures through effective bond splitting of NO and O_2, respectively, by electron capture in their antibonding molecular orbitals.

In order for utilization under realistic conditions, silicon carbide (SiC), which is well known as a chemically and thermally stable material, can be substituted for Si as a substrate.[5] Indeed, it has been evidenced that the Pt clusters supported on the SiC substrate, which are prepared by the cluster impact onto the SiC surface, can be taken out of the vacuum chamber with maintaining the low-temperature catalytic activities in the NO reduction and the CO oxidation.[9] Furthermore, this specific catalytic performance is durable at as high as 1200 K and at the atmospheric pressure.[9]

Species possessing accumulated electrons are promising as catalysts including the bond splitting, which is generally a key step of catalytic reactions such as O_2 splitting for oxygen reduction reaction (ORR) in a fuel cell, H_2O splitting for H_2 production (HER) in artificial photosynthesis, etc. In order for practical application of the supported clusters as functional materials of catalysis and others such as permanent magnets,[10] mass synthesis and global analysis are unavoidable. As a way to overcome this kind of issues, our approach to the laboratory automation is shown at the end of the talk.

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