Stabilization of alloy nanoparticles on reduced graphene oxide for catalytic application: Utilization of graphene oxide as a capping agent

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Nanoparticles (NPs) of pure metal and alloy composition have attracted much attention in catalytic application because they provide high activity in chemical reaction. It has been widely known that materials in nano-scale display unique chemical and physical properties which are drastically different from those of bulk materials[1]. The catalytic properties of metal nanoparticles generally depend on their size and shape. However, surface area-to-volume ratio becomes larger with decreasing the particle size, which leads to high reactivity and results in agglomeration during the synthesis[2]. One of effective methods to avoid the agglomeration of fabricated particles is to use supporting materials. Reduced graphene oxide (rGO) is one of promising supporting materials for NPs in catalytic application. It has large surface area and high hydrophilicity because its carbon layer is heavily covered by oxygen-containing groups, and this also makes it suitable substrate for metal NPs during reduction process in solution[3]. However, it has still a major difficulty in obtaining well dispersed metal NPs with small particle size on rGO. Therefore, a new strategy for controlling distribution and size of metal NPs on the rGO is required for the preparation of heterogeneous catalyst. Herein, for the first time, we report the immobilization of fine PtAu alloy NPs on rGO using GO as a capping agent. First, dilute solution of GO with the concentration of 10 %v/v was mixed with a mixture of ion solution of Pt and Au, then irradiated by highly intense femtosecond laser pulses (10^{14}-10^{16} W/cm^2). After the synthesized alloy NPs were supported on the GO matrix, hybrid catalyst of alloy NPs on rGO was prepared by a laser induced photoreduction method applying relatively weak laser intensity (8 x 10^{11} W/cm^2). Because of GO used as a capping agent, the size distribution of NPs became narrower and its dispersion state was much improved in comparison with that without additives. In addition, the alloy NPs was well distributed on rGO substrate with the average particle size of 6.4 nm. This technique is a simple process for realizing heterogeneous catalyst of metal/alloy NPs and rGO.

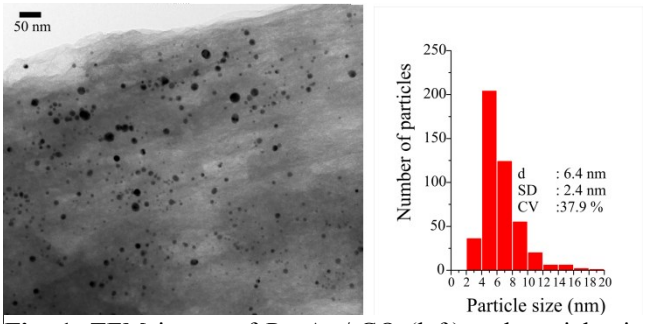

Fig. 1. TEM image of $Pt_{50}A_{50}$/rGO (left) and particle size distribution (right).

References

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2. F. Zaera et al., *Chem. Soc. Rev.*, **42**, 2746 (2013).
3. C. Tan et al., *Mater. Today*, **16**, 29 (2013).