Supporting information

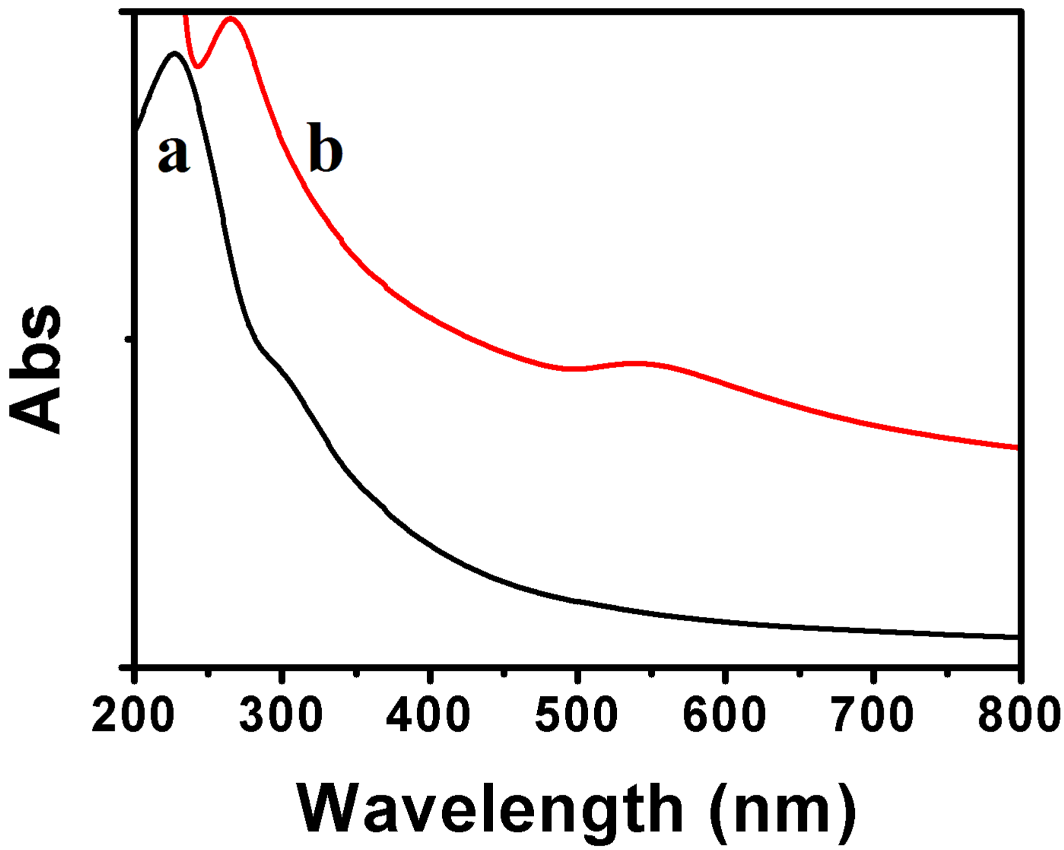


Fig. S1 UV-Vis absorbance spectra of GO (a) and rGO−Au NPs (b).

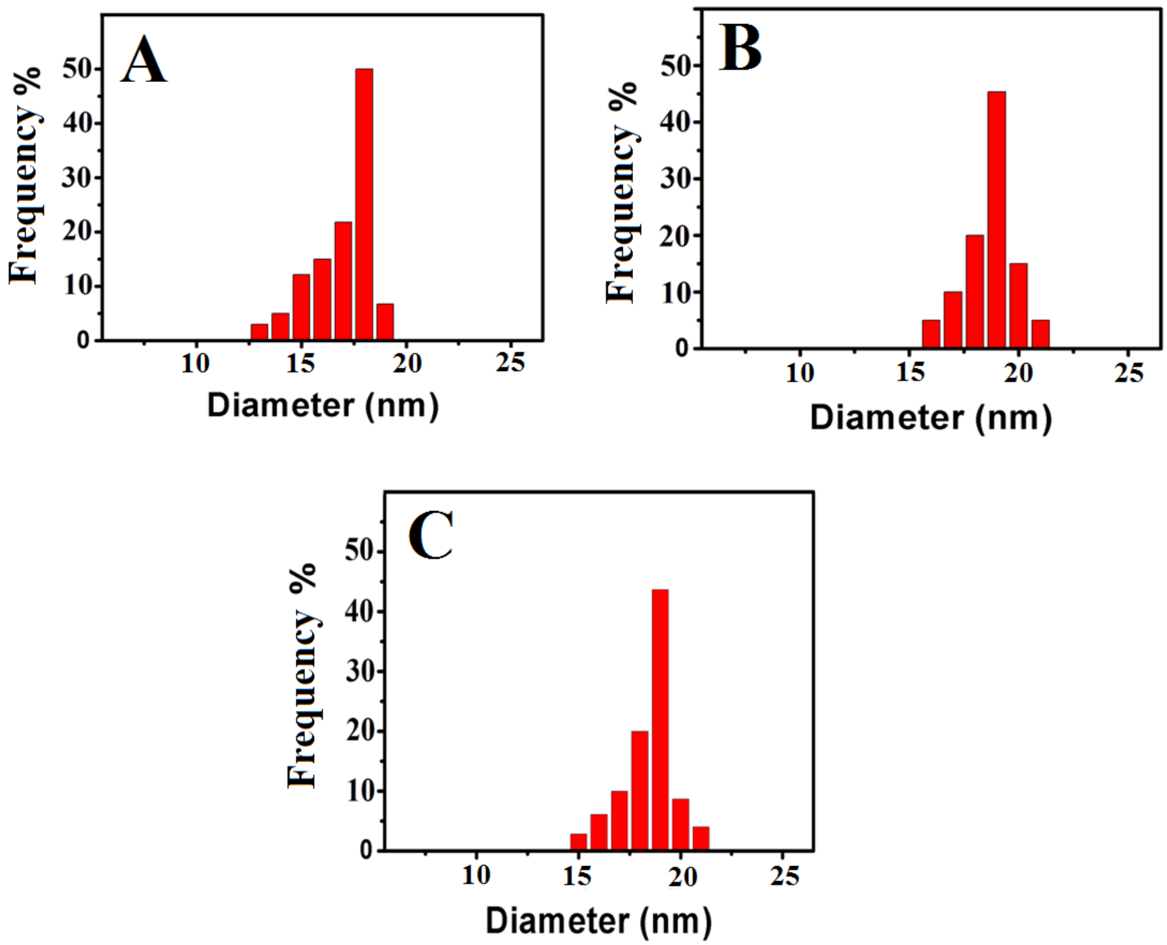
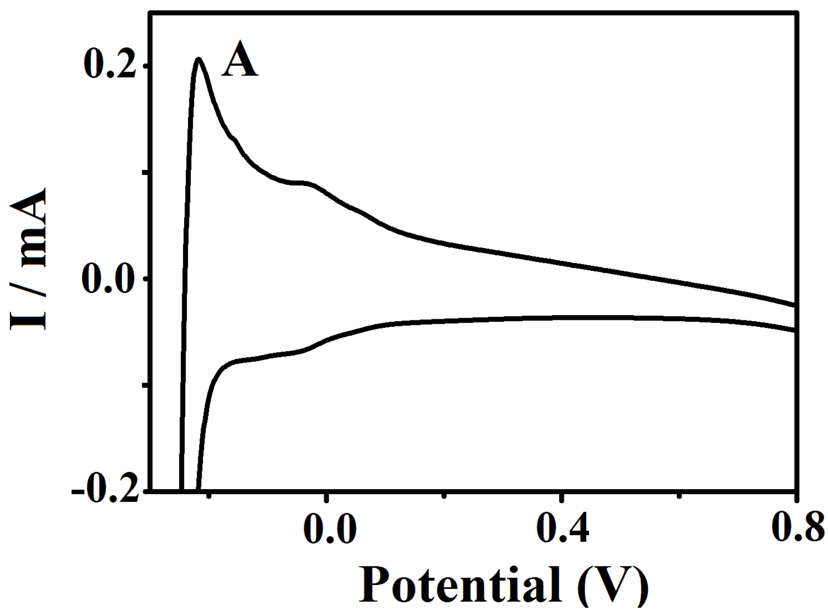


Fig. S2 Size distribution analyses of rGO−Au NPs (A), rGO−Au@Cu NPs (B) and rGO−Au@Pt NPs (C).



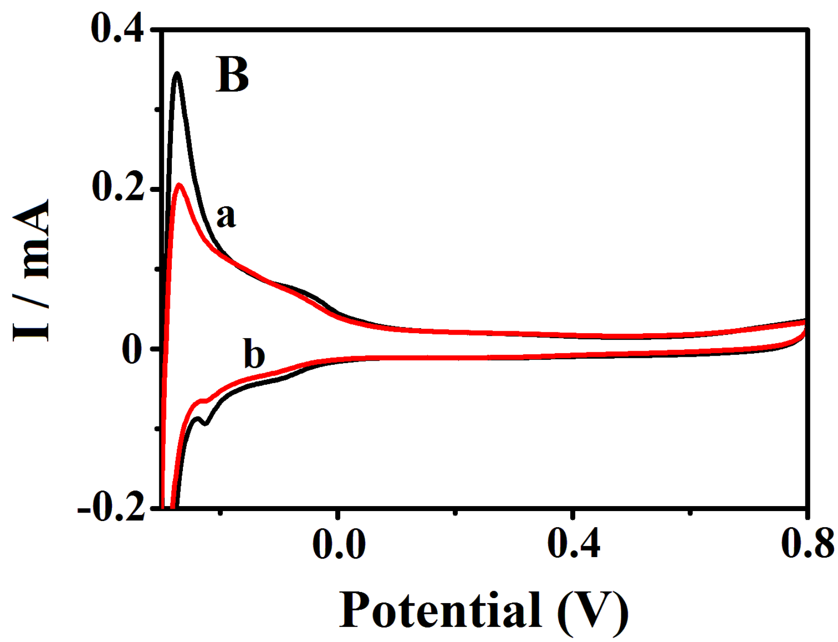


Fig. S3 CV curves of rGO−Au@Pt NPs decorated electrode (A) and Pt_{40}/C (B(a)) and Pt_{20}/C (B(b)) coated electrodes in 0.1 M H_2SO_4 at a scan rate 50 mV s^{-1}.

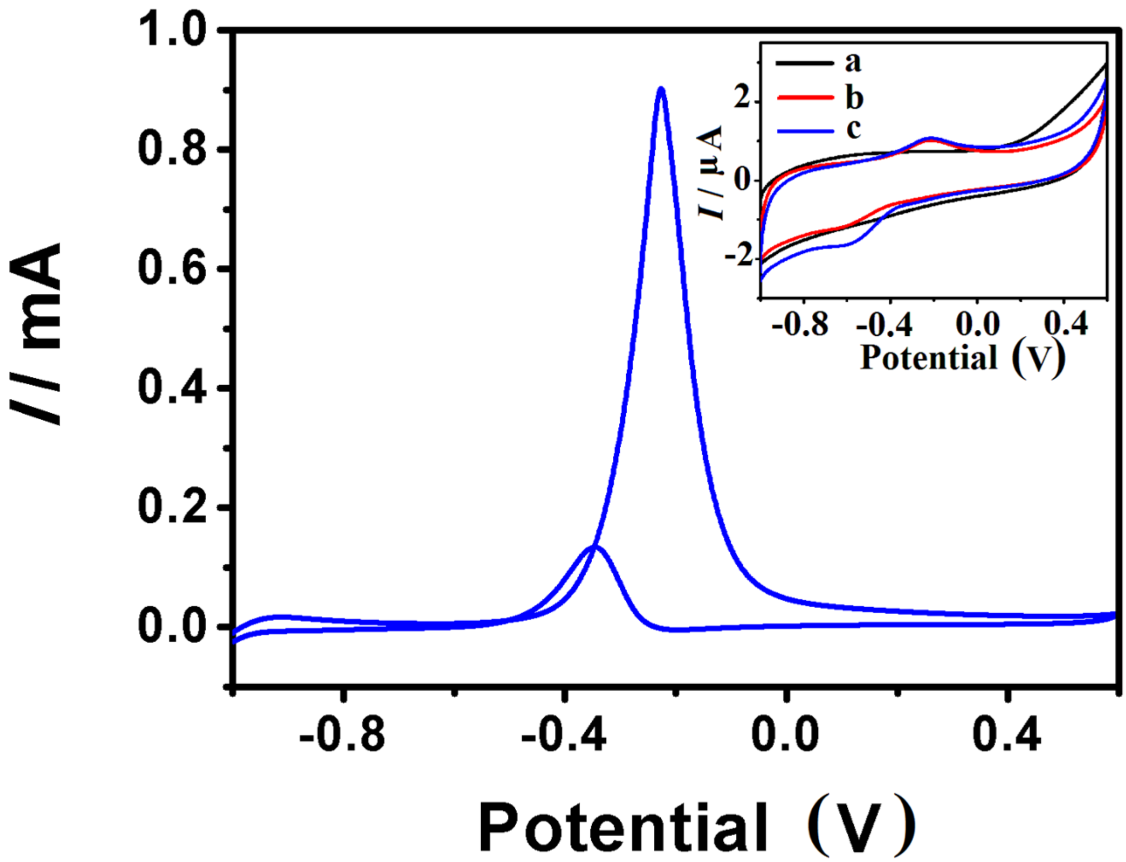


Fig. S4 CV curve of rGO−Au@Pt NPs decorated electrode in 0.5 M methanol containing 0.5 M NaOH at a scan rate of 50 mV s^{-1}. Inset: CV curves recorded at the identical condition for plain GC (a), rGO−Au NPs (b) and rGO−Au@Cu NPs (c) decorated electrodes.

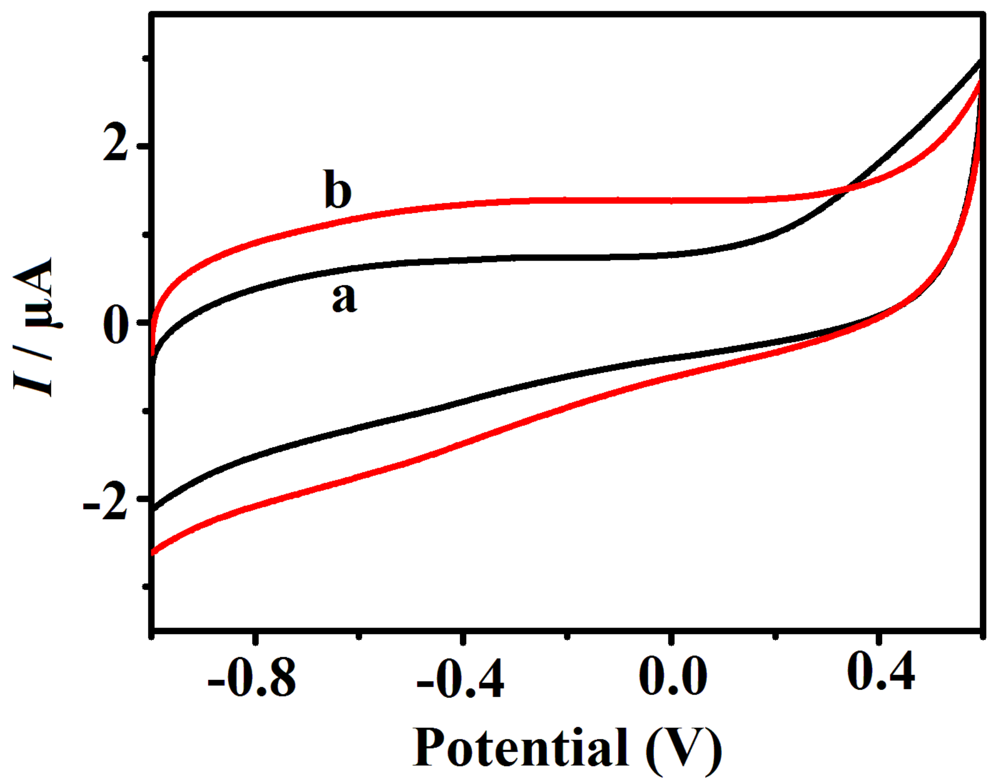


Fig. S5 CV curves of rGO decorated electrode in 0.5 M methanol containing 0.5 M NaOH (a) and 0.5 M ethanol containing 0.5 M NaOH (b) at a scan rate of 50 mV s^{-1}.

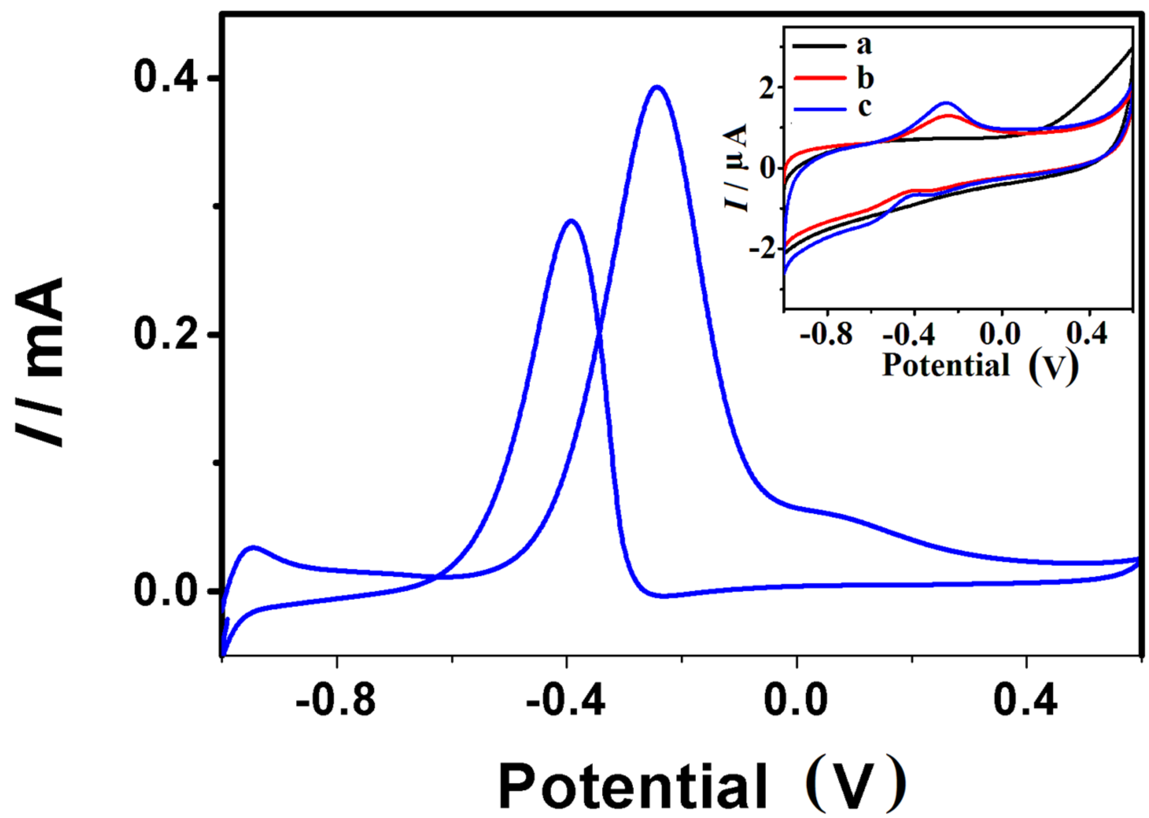


Fig. S6 CV curve of rGO−Au@Pt NPs decorated electrode in 0.5 M ethanol containing 0.5 M NaOH at a scan rate of 50 mV s^{-1}. Inset: CV curves recorded at identical condition for plain GC (a), rGO−Au NPs (b) and rGO−Au@Cu NPs (c) decorated electrodes.

Calculation of number of Au and Pt atoms present at rGO−Au@Pt NPs

$V_{cluster} = NV_{atom}$ **(1)**

$4/3\ \pi\ (R_{cluster})^3 = N\ 4/3\ \pi\ (R_{atom})^3$ **(2)**

Where, V is the volume of cluster or atom, R is the radius of cluster or atom and N is the total number of atoms in the cluster

$R_{cluster} = N^{1/3}\ R_{atom}$ **(3)**

The surface area (S) of the nanoparticles can be calculated using the following equation:

$S_{cluster} = 4\ \pi\ (R_{cluster})^2$ **(4)**

Dividing the surface area of the cluster with the cross section of an individual atoms, the number of surface atoms on the cluster would be calculated using the following equation:

$Ns = (4\ \pi\ (R_{cluster})^2) / (\pi\ (R_{atom})^2) = 4N^{2/3}$ **(5)**

From the HRTEM results the radius of Au NPs on rGO (rGO−Au) $R_{cluster} \approx 9$ nm was calculated ($R_{atom} = 0.137$ nm). The total number of Au atoms present in the Au nanoparticles was calculated using the equation (3):

$N = (R_{cluster}/R_{atom})^3 = ((9\times10^{-9}) / (0.137\times10^{-9}))^3$

N = 2,83,508 number of Au atoms present per nanoparticle

For convienience, since the radius of Au and Pt atoms are around 0.137 nm. Thereby, we assume the same type of atoms exist in the core-shell nanoparticle.

Radius of Au@Pt NPs on rGO (rGO−Au@Pt) $R_{cluster} \approx 9.5$ nm and R_{atom} is 0.137 nm, the total number of gold and platinum atoms present in the cluster is

$N = (R_{cluster}/R_{atom})^3 = ((9.5\times10^{-9}) / (0.137\times10^{-9}))^3$

$N = 3,33,433$ number of Au and Pt atoms present per nanoparticle

$N_{core\text{-}shell} - N_{core} = N_{shell}$

$N_{shell} = 3,33,433 - 2,83,508 \quad = 49,925$ Pt atoms present as shell material

According to the eqn. 5:

$N_s = 4N^{2/3} = 4\times(3,33,433)^{2/3} \quad = 19,233$ Pt surface atoms per nanoparticle.[1, 2]

It means 19,233 number of Pt atoms are sufficient to form a monolayer on the surface of Au NPs whereas 49,925 number of Pt atoms are exist at rGO−Au@Pt NPs. Thus, it infers as thin two atomic layers of Pt shell is exist on Au at rGO−Au@Pt NPs.

According to this calculation the weight percentage of Au and Pt at rGO−Au@Pt NPs are 85 % and 15 %, respectively. It is exactly coincide with the EDAX line scanning elemental weight percentage.

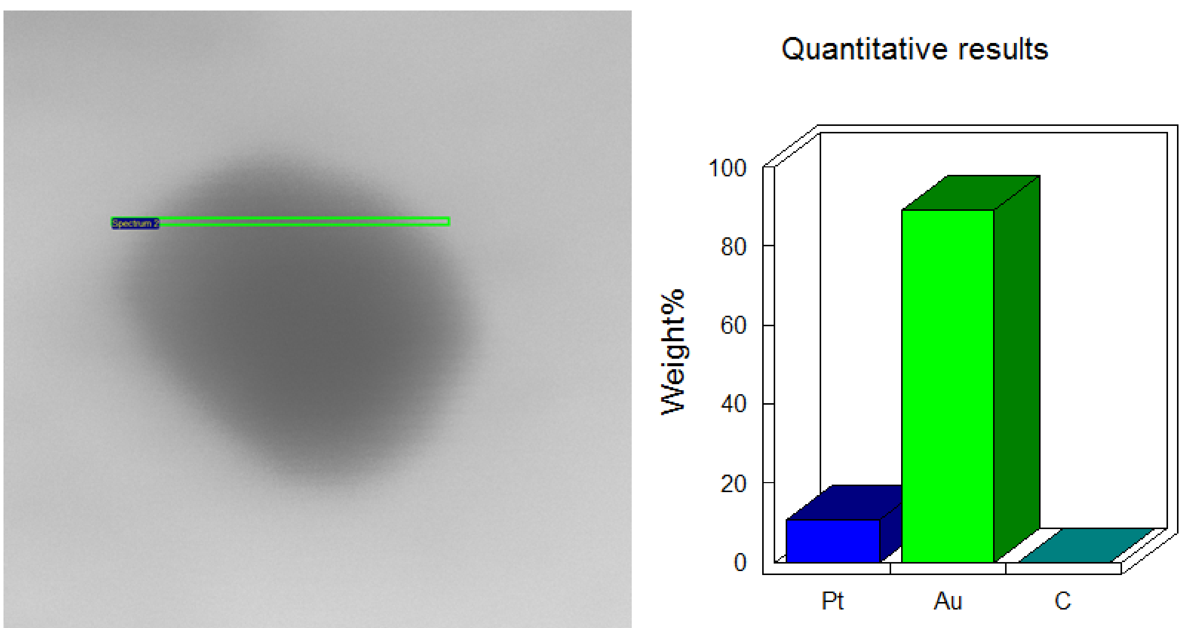


Fig. S7 EDAX line scanning analysis.

References

(1) D. F. Yancey, L. Zhang, R. M. Crooks and G. Henkelman, *Chem. Sci.,* 2012, **3**, 1033-1040.

(2) D. J. Lewis, T. M. Day, J. V. MacPherson and Z. Pikramenou, *Chem. Commun.,* 2006, 1433-1435.