Oxygen reduction reaction on glassy carbon electrodes modified with amino-functionalized carbon nanotubes and iron phthalocyanines

Paulina Cañete-Rosales, J. Francisco Silva, José H. Zagal
Departamento de Química de los Materiales, Universidad de Santiago de Chile, Santiago, Chile
paulina.canete@usach.cl.
Av. Libertador Bernardo O`Higgins 3363, Santiago
Estación Central 9170022, Chile

The oxygen reduction reaction (ORR) is an important process for energy conversion systems such as fuel cells and air batteries. The ORR presents two major problems :one of them is the high overpotential required for the reaction to proceed and the second is the high cost of Pt-based materials, which are the best catalysts for acid media. Carbon-based and modified carbon electrodes are being developed for low cost catalytic materials [1]. At the moment, the catalytic properties of nitrogen-doped multi-walled carbon nanotubes (N-CNT) have received increasing attention as ORR catalyst due to better resistance toward CO poisoning compared to Pt-based catalysts. The role of nitrogen seems to be to induce actives sites for the breaking of the O-O bonds of oxygen molecules [2]. This is crucial for the 4-electron reduction of O_2. In this work we propose an alternative to doped carbon nanotubes (N-CNT), using amino-functionalized CNTs. The catalytic activity of metallophthalocyanines (MPcs) for the ORR is well-known [3], especialy in alkaline media. The advantage of these systems is that these macrocyclics adsorb strongly on graphite and carbon-based electrode materials allowed us to prepared an hybrid CNT-MPc material.

The amino-functionalized multi-walled carbon nanotube (amCNT) functionalized with iron phtalocyanine (FePc) and iron hexadecachloride phtalocyanine ($FeCl_{16}Pc$) have been studied as catalysts for ORR in acidic and basic media. Cyclic and linear sweep voltammetry were used to characterize the modified electrodes. Cyclic voltammetry and rotating disk electrode were used to investigate the electrocatalytic activity of the GCE/amCNT/FePc and GCE/amCNT/$FeCl_{16}Pc$ for ORR. Our results shows that amCNT-FePcs hybrid material as modified film onto glassy carbon electrodes improves the electrocatalytic response of the electrode for the ORR. CNTs by themselves are good electrocatalysts for the ORR but the presence of iron phthalocyanines on their surface induces an important displacement on the starting potential (or foot of the wave) of the ORR to more positives values. Also an increase on the limiting current value is observed. The best hybrid-modified electrode was GCE/amCNT/$FeCl_{16}Pc$ in both acidic and basic media. The modified electrodes shown to be highly stable and gave reproducible results. Allsystems containg Fe phthalocyanines promote the 4-electronreduction to O_2.

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References

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