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Obtaining a Hybrid Electrode based on Imidazonium Ion- terminated and Metallic Nano-clusters for Battery Electrode use

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ABSTRACT

In the present work, we focused on the grafting of thin film positively charged based on ionic liquids (LIs) on a glassy carbon electrode (GC), then functionalized with metal nanoparticles (Pt or Pd). The SEM obtained images confirm the modified electrode. Interestingly, the catalytic performances of hydrogen evolution reaction (HER) are improved for both prepared electrodes (GC/LI/Pt, GC/LI/Pd), especially the latest one containing palladium. It seems that the ionic layer presence displays an increase catalytic, which is probably due to the synergistic effect existence between the grafted ionic layer and the metallic nanoparticles.

Key words: Ionic Liquid, Nanoparticles, Modified electrode, Electrocatalysis, Hydrogen evolution reaction.

1. Introduction

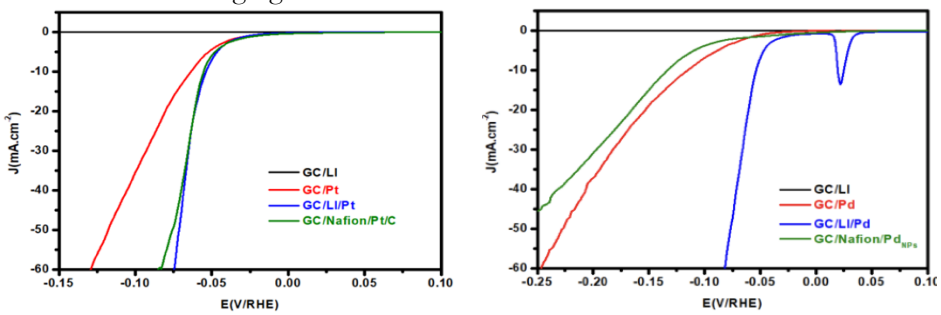
Surface chemistry offers an interesting approach to modulate the materials properties and among the electrochemical methods the diazonium derivatives reduction is the most used and attractive approach [1], in which we are interested. In this work, we have chosen an ionic liquid as diazonium. After grafting the post-functionalization is complementary approach leading to enhance surface modification and to decorate the previously modified electrode surface. For this purpose, several strategies were reported including chemical surface reaction, *i.e.* peptide coupling, Gomberg-Bachmann coupling and click chemistry, and electrochemical deposition [2,3,4].

2. Experimental

In this work, the GC was initially modified by electrografting of LI (1-nitrophenylethyl 3-methylimidazolium bis(trifluoromethyl- sulfonyl)imide, [NO_2-phenyl-Im] [TFSI]), according to the previously reported procedure [5]. Then the GC/LI electrode was functionalization with platinum or palladium. So, GC/LI was immersed in aqueous electrolytic solution containing 10^{-3} mol/L of K_2PtCl_4 or Na_2PdCl_4, then a chronoamperometry was performed, by applying negative potentials of -0.4 V/Ag/AgCl, to produce the GC/LI/Pt and GC/LI/Pd.

3. Results and discussion

The electrocatalytic performances of the generated GC/LI/metal NP towards the HER were investigated and reported in the following figure.



The Fig. analysis shows that the GC/LI/Pt required overpotential about 52 mV to achieve a current density of 10 $mA.cm^{-2}$, which is comparable to commercial Pt/C sample (55 mV). Interestingly, at higher current

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density (-60 mA.cm^{-2}), the required over potential on GC/LI/Pt is 74 mV, while 84 mV and 130 mV are required on commercial Pt/C and GC/Pt, respectively.

The GC/LI/Pd exhibits the best HER performance with a lowest onset potential (- 10 mV) and low overpotential (53 mV) to reach a current density of 10 mA.cm^{-2}, which is lower than those measured with GC/Pd (114 mV) and GC/Nafion/Pd$_{NPs}$ (133 mV). The GC/LI/Pd displays electrocatalytic performances similar to that recorded on commercial Pt/C.

4. Conclusions

This work demonstrates that the ionic layer electrochemical grafting leading to imidazolium moieties onto GC and its further functionalization through electrochemical deposition of metallic nanoparticles (Pt and Pd). The electrolytic activities towards HER of the generated modified electrodes confirm that the HER activity and kinetic on Pt and Pd nanoparticles are enhanced in the ionic layer presence. More interestingly, the GC/LI/Pd exhibits excellent HER performances more efficient than commercial electrode (Pt/C). This behaviour is probably related to the dual role of the attached ionic layer, which acts as a host–guest platform for the electrocatalyst and also to the synergetic effect between the ionic layer and the NP's. This approach is a promising route to generate polymer binder free electrocatalyst and to enhance the intrinsic catalyst electrocatalytic performances.

References

[1] J. Pinson, F. Podvorica, Attachment of organic layers to conductive or semiconductive surfaces by reduction of diazonium salts, Chem. Soc. Rev. 34 (5) (2005) 429, https://doi.org/10.1039/b406228k

[2] J. Ghilane, G. Trippe-Allard, J.C. Lacroix, Grafting of imidazolium ion- terminated layer using electrochemical reduction of diazonium: redox active counter anion exchange within the layer, Electrochem. Commun. 27 (2013) 73–76

[3] J. Ghilane, J.C. Lacroix, Formation of a bifunctional redox system using electrochemical reduction of platinum in ferrocene based ionic liquid and its reactivity with aryldiazonium, J. Am. Chem. Soc. 135 (12) (2013) 4722–4728

[4] J. Ghilane, F. Hauquier, J.C. Lacroix, Oxidative and stepwise grafting of dopamine inner sphere redox couple onto electrode material: electron transfer activation of dopamine, Anal. Chem. 85 (2013) 11593–11601

[|5] M. Gómez-Mingot, V.B. Thi-Tuyet, G. Trippé-Allard, J. Ghilane, H. Randriamahazaka, Oxidative grafting of a redox-molecule-based ionic liquid onto an electrode surface: anion exchange within a layer, ChemElectroChem. 1 (2014) 1467–1470

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