CHARACTERIZATION OF Ru/Pt/C NANOCATALYST PREPARED BY ROTATING DISK-ELECTRODE (RoDSE) TECHNIQUE

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Of the pure metals, platinum has shown the highest activity for methanol oxidation[1], but the poor performance of pure platinum for methanol oxidation results from the strong adsorption shown by CO on the metal. In order to overcome the blocking effect of CO on platinum, it can be alloyed with other metals to produce materials that exhibit catalysis rates considerably higher for methanol electro-oxidation than pure platinum[2]. Bimetallic Pt-Ru systems are promising electrocatalysts for methanol electro-oxidation, which afford significant current enhancements at given potentials compared to pure platinum. These systems, in high surface area form on unsupported or supported on carbon black, behave as excellent catalysts for direct methanol fuel cells. It is known that ruthenium promotes the electro-oxidation of methanol on platinum; the detailed explanation for its catalytic influence on this reaction is still a matter of discussion. In this work we propose the preparation of the Ru/Pt/C catalysts by rotating disk-slurry electrode techniques using the high surface area carbon black.

The major goal in fuel cell area is prepare catalytic with small particle size to obtain high surface area. For this I'm introducing a novel technique using rotating disk electrode called rotating disk-slurry electrode technique (RoDSE). In this investigation we used the carbon black as support. Carbon black has a great surface area and this is very important for this investigation. For the ruthenium electrodeposition, we use $Ru(NO)(NO_3)_3$ and the commercial catalyst, 20% Pt-vulcan XC-72R from E-tek. The purpose of this study is to observe the Ru behavior when it was electrodeposited over the 20% Pt/C commercial catalyst at different potential with the RoDSE technique. In this study we used 200 mV, 100 mV, 0 mV, -100 mV, and -200 mV. With the convection of this technique and the support used is expected that the metal deposition was carried out at different side of the support particle avoiding the conglomeration of the metal nanoparticles.

The TEM images demonstrate that the carbon surface has particles deposited over it, but only with the TEM imagine we can't determine if the Ru is deposited over the Pt/C surface (see figure 1). For this reason, we performed TEM-EDS analysis. Figure 2a is the EDS analysis of 20% Pt/C commercial catalyst that has the characteristics Pt peaks. Figure 2b is the EDS analysis of Pt/C catalyst after the Ru electrodeposition at constant potential of -200 mV. With this analysis we can see that the Pt/C nanocatalyst has Ru, because this EDS spectrum has an additional peak corresponding to Ru. The XPS analyses corroborate the TEM-EDS analysis when high resolution analysis for the Ru $3p_{3/2}$ peak was done (figure 3). The EDS mapping and XRD analysis also show the Ru presence on the Pt/C nanocatalyst.

In summary the rotating disk-slurry electrode is an appropriate technique for the metal electrodeposition, because avoid conglomeration over the catalyst support material. All the characterizations corroborate the ruthenium presence on the 20% Pt/C commercial catalyst. In future work we are going to do electrochemical characterization of the Ru/Pt/C nanocatalyst.

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[1] H. Bolivar, S. Izquierdo, R. Tremont, and C.R. Cabrera. *J. Appl. Electrochem.* **2003**, 33, 1191

[2] Y. Ishikawa, M-S. Liao, C. R. Cabrera. *Surface Science* **2000**, 463, 66
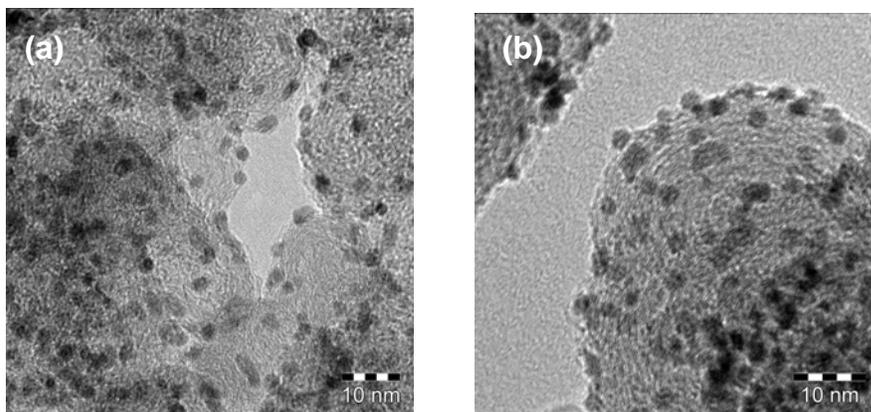
Figure 1: TEM imagine of (a) 20% Pt/C commercial catalyst, (b) Ru electrodeposited at -200 mV over 20% Pt/C commercial catalyst.
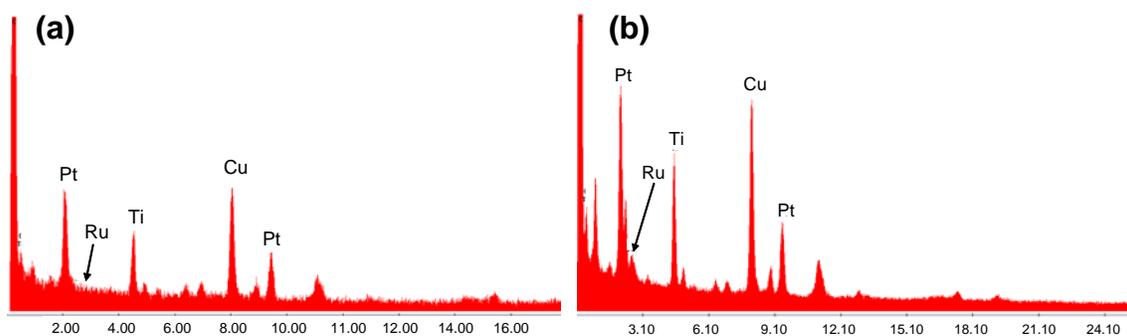
Figure 2: EDS spectrum of (a) 20% Pt/C commercial catalyst, (b) Ru electrodeposited at -200 mV over Pt/C commercial catalyst.
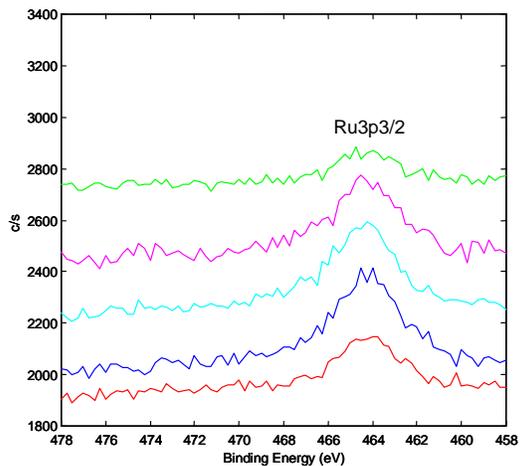
Figure 3: High resolution XPS analysis for Ru/Pt/C nanocatalyst prepared using: 200mV (red line), 100mV (dark blue line), 0 mV (light blue line), -100 mV (pink line) and -200 mV (green line).