Evaluation of different polyurethanes in preparation of composite electrodes

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Introduction

Polyurethane (PU) is a polymer resulting from the reaction between an isocyanate and a hydroxyl group usually from a polyhydric alcohol (polyol) and represents materials with several applications [1].

Composite electrodes are composed by one conducting and one insulating phase, which also acts as an agglutinant[2].

In this study, three different commercial PUs were used in the preparation of composite electrodes, PU – vegetable derivative; 15-12 and 15-3 petrolium derivative. The actual content of graphite in each composite was determined by thermogravimetry and the voltammetric response was evaluated using potassium ferricyanide 1.0 mmol L^{-1}, in KCl 0.50 mol L^{-1} as electrochemical probe.

Results and Discussion

The thermogravimetric curves were taken under the following conditions:

- ✓ Sample mass 7.0 mg (± 0,1µg)
- ✓ Ramp from 10ºC min^{-1} to 800ºC in Nitrogen atmosphere (50 mL min^{-1});
- ✓ Ramp from 10ºC min^{-1} to 1000ºC in air atmosphere (50 mL min^{-1})
- ✓ Open *α*-Alumina crucible

Thermogravimetric residues for the three PU analyzed, as well as their graphite composites, are presented in Table 1. Isolated resins produced residues around 7.0% at 800 ºC under N_2 atmosphere. After this temperature, sample were submitted to heating until 1000 ºC, under air atmosphere, leading to residues of *c.a.* 2.0%. Composite materials presented residues of ~ 63.0-67.0% at 800 ºC under N_2 atmosphere and ~0-0.3% after burning in air. A distinct behavior was observed for PU 15-3, that presented higher values of residue in N_2, as well as in air atmosphere. This values were used to calculated the actual graphite content in composite electrodes, which are also presented in Table 1. The composites prepared with different resins presented graphite content around 60%, as expected. However, composite electrode prepared with this PU resulted in higher intensity of anodic and cathodic currents, Table 2, and presented better voltammetric profile in cyclic voltammetry.

Table 1. Graphite contents present in the analyzed composites

Sample	Residues/ %				Graphite / %
	Composite		Polyurethane		
	N_2 [a]	Air [b]	N_2 [a]	Air [b]	
PU	69.0	0.3	6.27	2.13	64.5
15-12	63.8	0.0	7.17	2.04	59.6
15-3	73.6	15.1	32.0	29.3	55.9

[a] percentage at 800 ºC
[b] percentage at 1000 ºC

Table 2. Values obtained from cyclic voltammetry using potassium ferricyanide 1 mmol L^{-1}, in KCl 0.5 mol L^{-1}, v = 25 mV s^{-1}

Composite	I_{pa} /µA	I_{pc} /µA	ΔE /V
GPU	12.2	-14.6	0.066
15-3	17.4	-21.3	0.064
15-12	12.0	-14.2	0.061

Differents thermal and voltametric behavior are discussed.

Conclusion

Three PU were used to prepare composite electrodes. TG curves permitted to determine the actual graphite content, as ~ 60%. The behavior presented by PU 15-3 is distinct probably due to the presence of inorganic additives. The composite electrode prepared with this resin resulted in higher current intensities.

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