# PANI-Rh Nanocomposites with catalytic properties for electronic devices

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**Abstract:** In this work, polyaniline (PANI)-rhodium composites have been obtained. The simultaneously deposition of PANI and Rh in a solution of 1M $HNO_3$, 0.1 M PAN and $3 \cdot 10^{-2}$M $Na_3RhCl_6$ synthesis has involved reduction of $Rh^3$. Oxidation of hydrogen confirmed the presence of Rh particles in the PANI matrix. Cyclic voltammetry was used to deposit the metal particles into the PANI matrix and electrochemical impedance spectroscopy to characterize the kinetics and electrocatalysis. The deposition of Rh nanoparticles in PANI matrix shows catalytic properties in electronic devices, sensors and anticorrosion coatings.

## 1. Introduction

Conducting polymers with porous structure and high surface area, such as polyaniline are usually used as matrix to incorporate noble metal catalysts [1, 4]. Nanoparticles of noble metals have attracted steadily growing attention due to their interesting optical, electrochemical, electronic, and photoelectrochemical properties. The reason for incorporating metallic particles into porous matrixes is to increase the specific area of these materials and thus improve catalytic efficiency. The polyaniline films were electropolymerized from a solution containing aniline monomer and 0.1 M $HNO_3$ by cycling potentials until the films reach certain thickness [2, 3].

Metal nanoparticles like gold, silver, palladium and rhodium exhibit remarkable optical properties. Rhodium nanoparticles were absorbed onto the surface of a thin polyaniline (PANI) film.

The purpose of the present paper is to characterize the PANI-Rh nanocomposite using electrochemical methods and report the presence of catalytic properties of the rhodium-polyaniline nanocomposites for applications in electronic devices.

## 2. Experimental

All electrochemical experiments were performed with a AUTOLAB PGSTAT-12 (ECO CHEMIE, Netherlands) by using a double-compartment glass cell with three-electrode configuration. A carbon working electrode (electrode geometric area: 0.124 $cm^2$),carbon electrode with 4 $cm^2$ geometric area and AgCl electrodes were used as counter and reference electrode, respectively.

The polyaniline films were formed on the carbon working electrode by cyclic voltammetry at $50 mVs^{-1}$ between 0 and 0.9V in a solution of 0.1M aniline+ 1 M $HNO_3$. The film thickness reached 10 numbers of potential cycles. Cyclic voltammetry was used to synthesize the PANI-Rh composites with a simultaneously deposition of PANI and Rh in a solution of 1M $HNO_3$, 0.1 M PAN and $3 \cdot 10^{-2}$M $Na_3RhCl_6$ at $50 mVs^{-1}$ between −0.25 V and 0.9V. The experiments were performed at ambient temperature (20 ◦C).

## 3.Results and Discussion

The electrochemical deposition of rhodium particles in the polyaniline films is achieved by cyclic voltammetry with varying cycle numbers, sweep rates and potential limits.

It is desirable that the adjustment of the electrochemical parameters allow the electrocatalytic nature of the composite electrode to be optimized. Fig. 1 shows the cyclic voltammograms during the electropolymerization of aniline on the carbon working electrode from a solution of 1M $HNO_3$, 0.1 M PAN and $3 \cdot 10^{-2}$M $Na_3RhCl_6$ containing 0.1M aniline, during 15 cycles in the potential limits from −0.25 to 0.9V at a sweep rate of $50 mVs^{-1}$. As can be seen, a successive growth of the electrodeposition of rhodium particles in the PANI matrix (at 0.1 - 0.25 and ~0.8 V), but also cathodic currents grows at ~-0.2 V and are more negative, which can be related only with allocation of hydrogen on the deposited rhodium. Cathodic peaks ( at ~0.15) appears, which can be explained by the oxidation of adsorbed hydrogen. Catalytic activity in both cathodic reduction and hydrogen oxidation convincingly shows, that the composite obtained has rhodium particles.

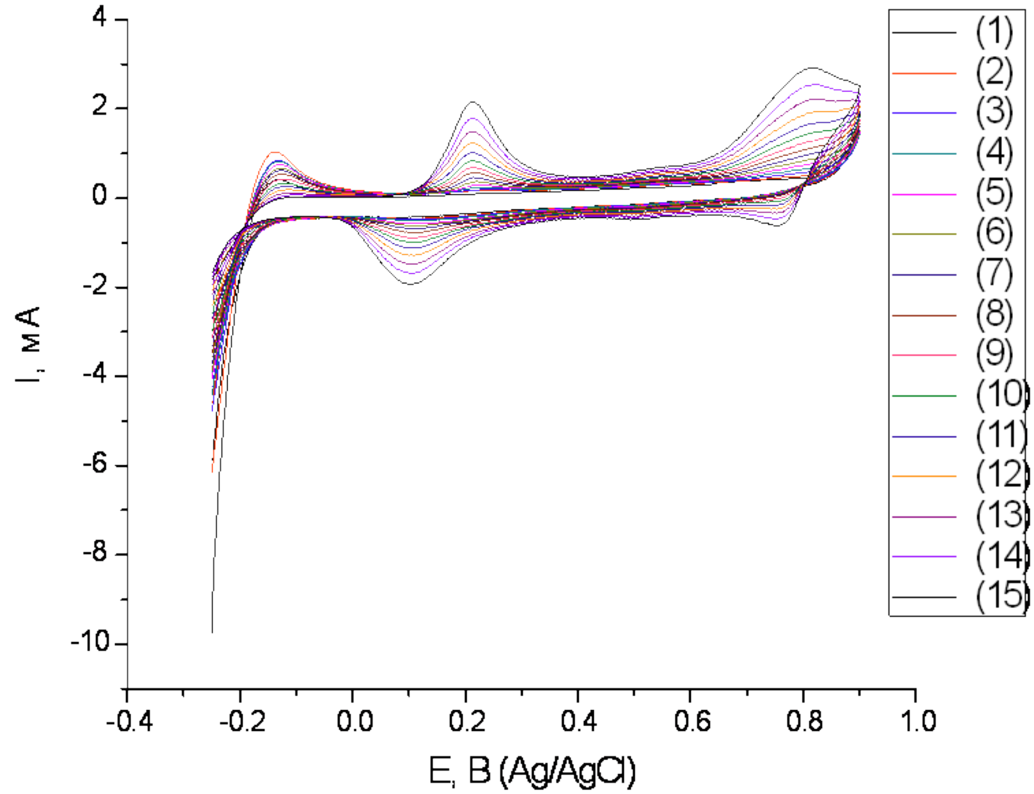


Fig.1. Cyclic voltammogram of the PANI-Rh system

## 4. Conclusion

The PANI-Rh system shows the dispersion of novel metal particles into the near-electrode layer polymer film and has direct contact with the electrode. The great total area surface of this composite allows catalytic applications in electronic devices and can also be used as energy source. The catalytic activity of the PANI-Rh system is demonstrated by the electro-reduction of hydrogen ions.

## 5. References

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