

N-DOPED WOOD DERIVED CARBON MATERIAL SUPPORTED WITH GOLD NANOPARTICLES AS AN EFFICIENT CATALYST FOR GLUCOSE ELECTRO-OXIDATION

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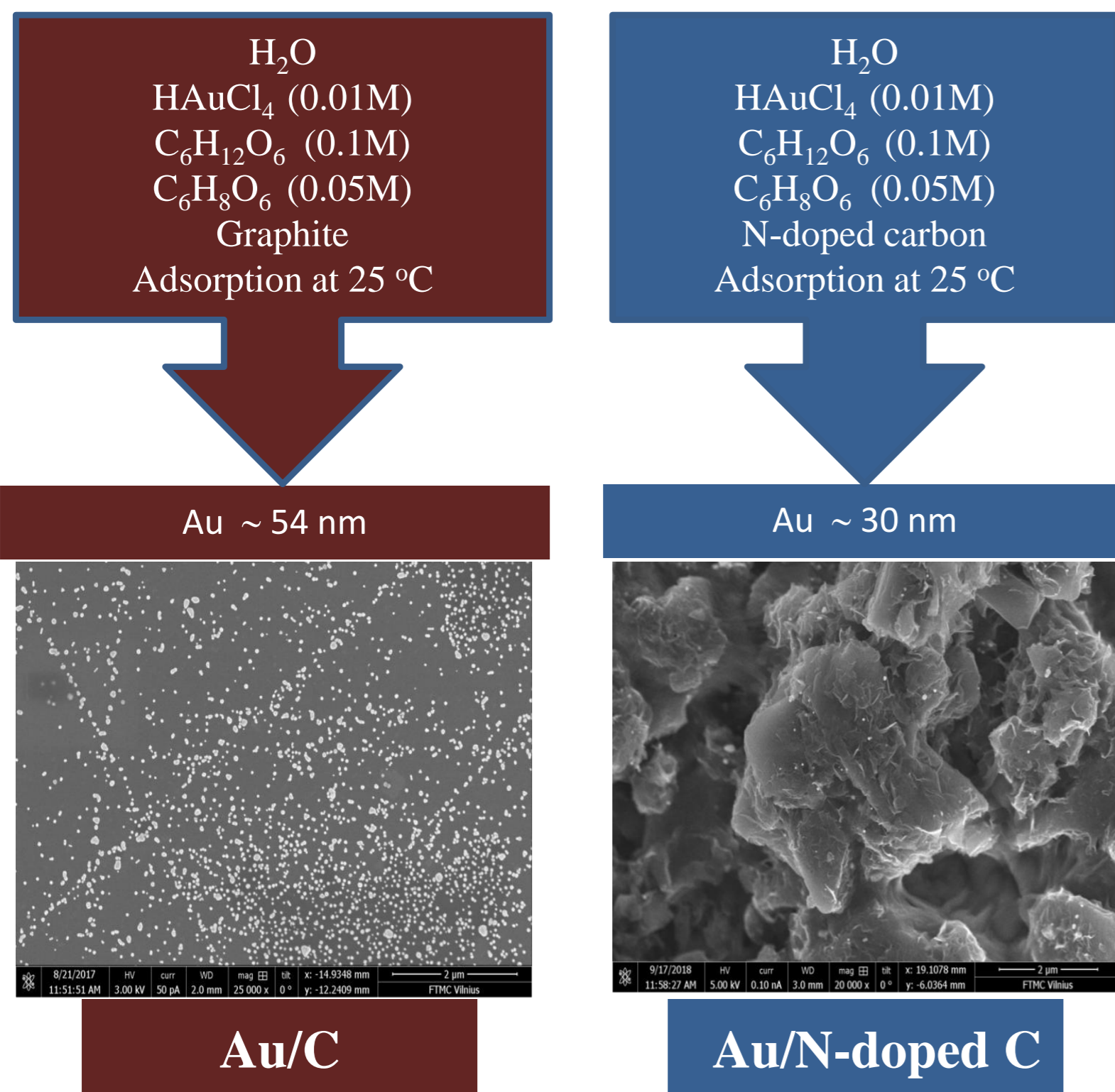


INTRODUCTION

This study is focused on the preparation of gold nanoparticles (AuNPs) supported carbon (C) and nitrogen-doped activated carbon (N-doped C) nanocomposites and their application for the electro-oxidation of glucose and oxygen electro-reduction. The AuNPs/N-doped C nanocomposite was prepared by two-step process. At first, activated wood-based carbon was prepared from alder charcoal and doped with nitrogen by pyrolysing samples at a temperature of 800 °C in the presence of dicyandiamide (DCDA). Further, the AuNPs were reduced from Au³⁺ (HAuCl₄) to Au⁰ in an aqueous solution using glucose (C₆H₁₂O₆) and ascorbic acid (C₆H₈O₆) mixture as a reducing agent and were deposited on the obtained N-doped activated carbon material or carbon by the adsorption method, using stirring.

The prepared nanocomposites were characterized by scanning electron microscopy (SEM), energy-dispersive spectroscopy (EDS), X-ray powder diffraction (XRD), Raman and X-ray photoelectron spectroscopy (XPS). The electrocatalytic activity of the nanocomposites for oxygen electro-reduction and glucose electro-oxidation was investigated using the cyclic voltammetry and rotating disk electrode (RDE) methods.

SYNTHESIS OF CATALYSTS



CHARACTERIZATION OF CATALYSTS

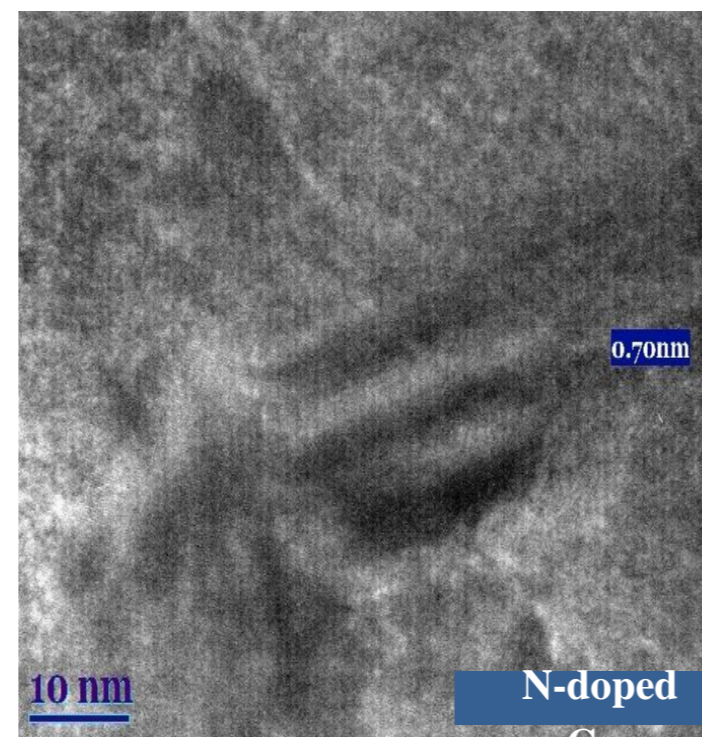


Fig. 1. TEM image of activated and N-doped wood based carbon.

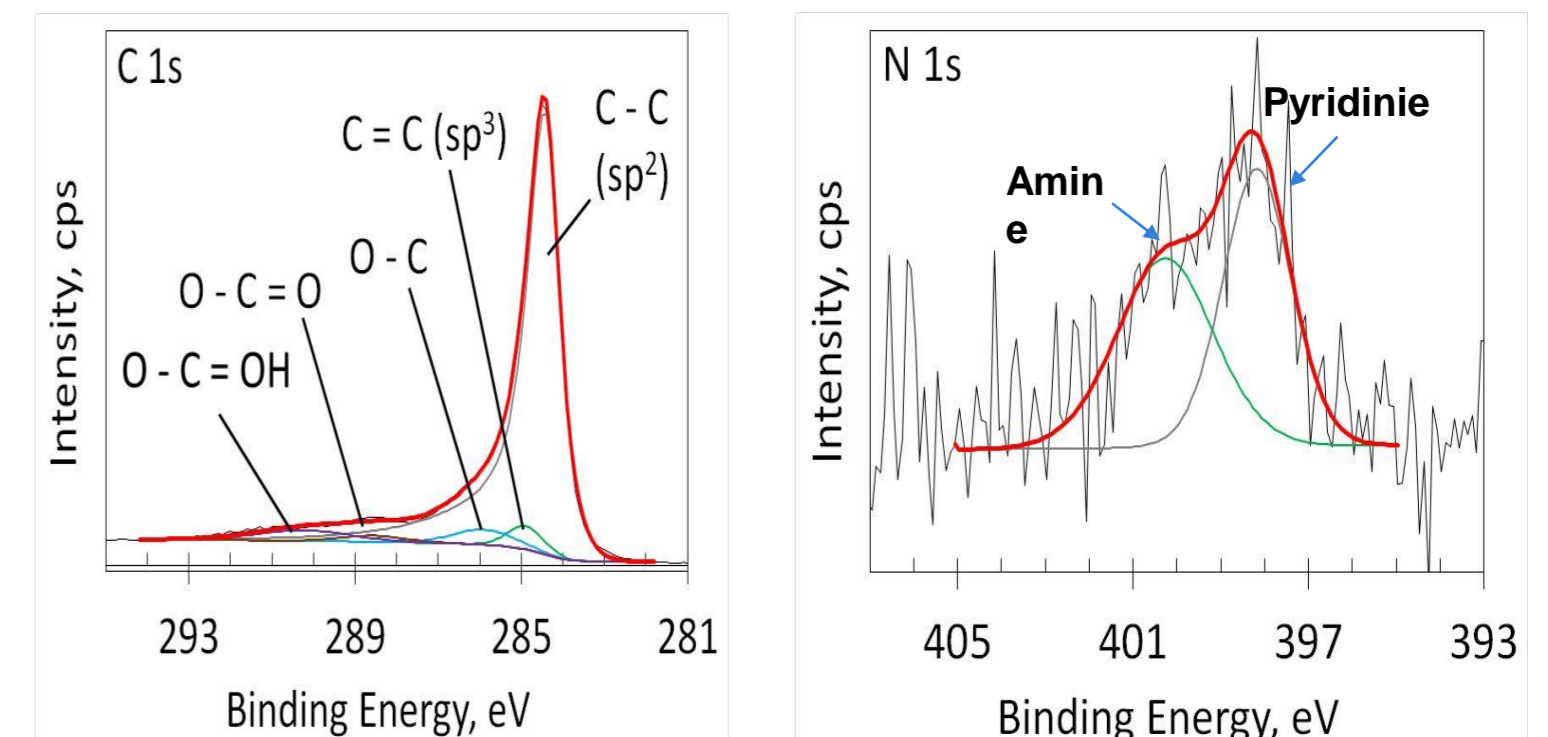


Fig. 2. Deconvoluted XPC1s and N1s spectra of N-doped wood based carbon.

ESA DETERMINATION

Table 1. The electroactive areas of Au surface on the synthesized catalysts determined from CVs of catalysts recorded in 0.5 M H₂SO₄ at a scan rate of 50 mV s⁻¹ by calculating the charge associated with the Au surface oxide stripping peak (400 μC cm⁻²).

Catalysts	ESA, cm ²	ESA, m ² g ⁻¹	Au loading, mg cm ⁻²
Au/C	0.12	3.08	0.056
Au/N-doped C	0.07	1.68	0.058

CONCLUSIONS

❖ It was found that current densities towards glucose electro-oxidation are ca. 1.3 times higher on the Au/N-doped C catalyst as compared to those at Au/C. Mass activity and specific activity are ca. 1.2 and ca. 2.1, respectively, times higher at Au/N-doped C than those at Au/C.

❖ The best catalytic characteristics show Au/N-doped C catalyst, which was synthesized using glucose and ascorbic acid mixture as reducing agents, and deposited on N-doped carbon powder by adsorption method.

ELECTRO-OXIDATION OF GLUCOSE

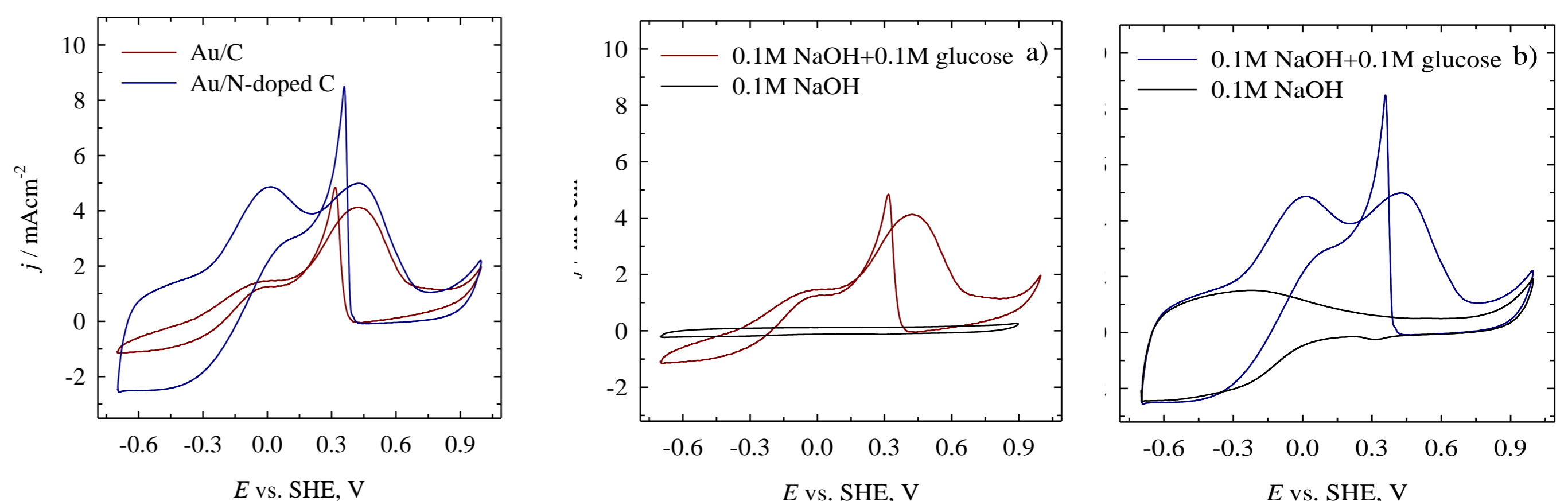


Fig. 3. Stabilized CVs (10th cycles) of the Au/C and Au/N-doped C catalysts recorded in the 0.1 M NaOH + 0.1 M glucose at a sweep rate of 50 mV s⁻¹.

Fig. 4. Stabilized CVs (10th cycles) of the Au/C (a) and Au/N-doped C (b) catalysts recorded in the background solution of 0.1 M NaOH and that contained 0.1 M glucose at a sweep rate of 50 mV s⁻¹.

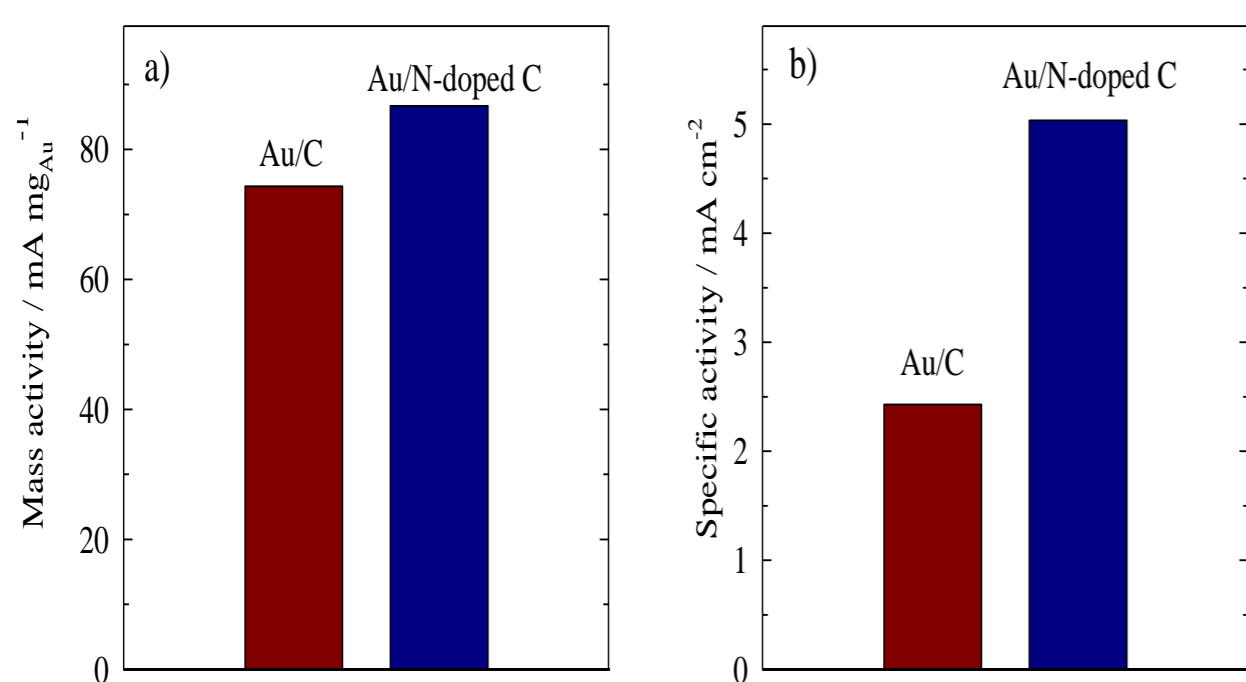


Fig. 5. Comparison of mass activity (a) and specific activity (b) towards the electro-oxidation of glucose for the Au/C and Au/N-doped C catalysts recorded in 0.1 M NaOH + 0.1 M glucose at 50 mV s⁻¹.

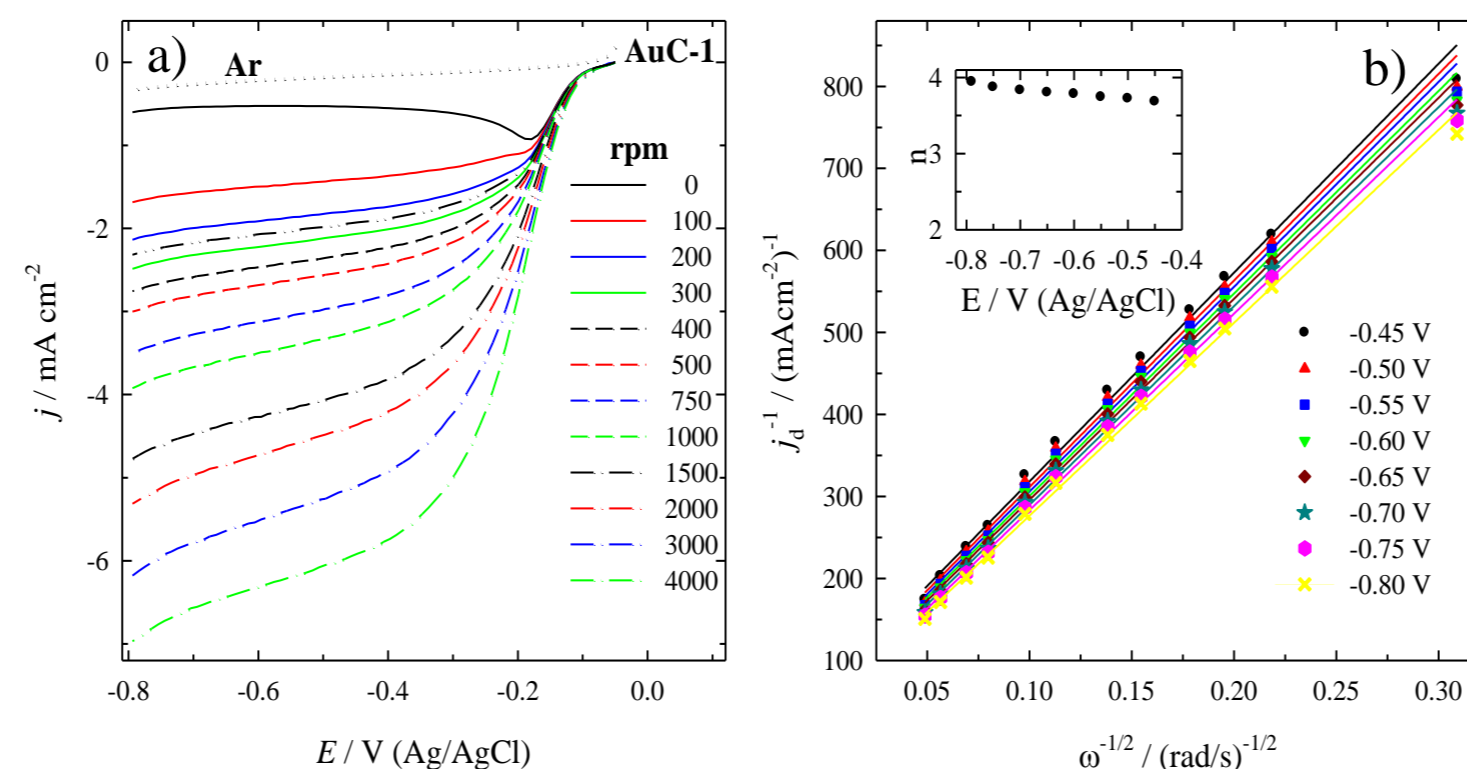


Fig. 6. LSV curves of Au/N-doped C catalysts obtained at different rotating rates in the O₂-saturated 0.1 M KOH solution at a scan rate of 10 mV s⁻¹ (a) and Koutecky-Levich plots for ORR in O₂-saturated 0.1 M KOH solution at different potential of the same catalyst (b).

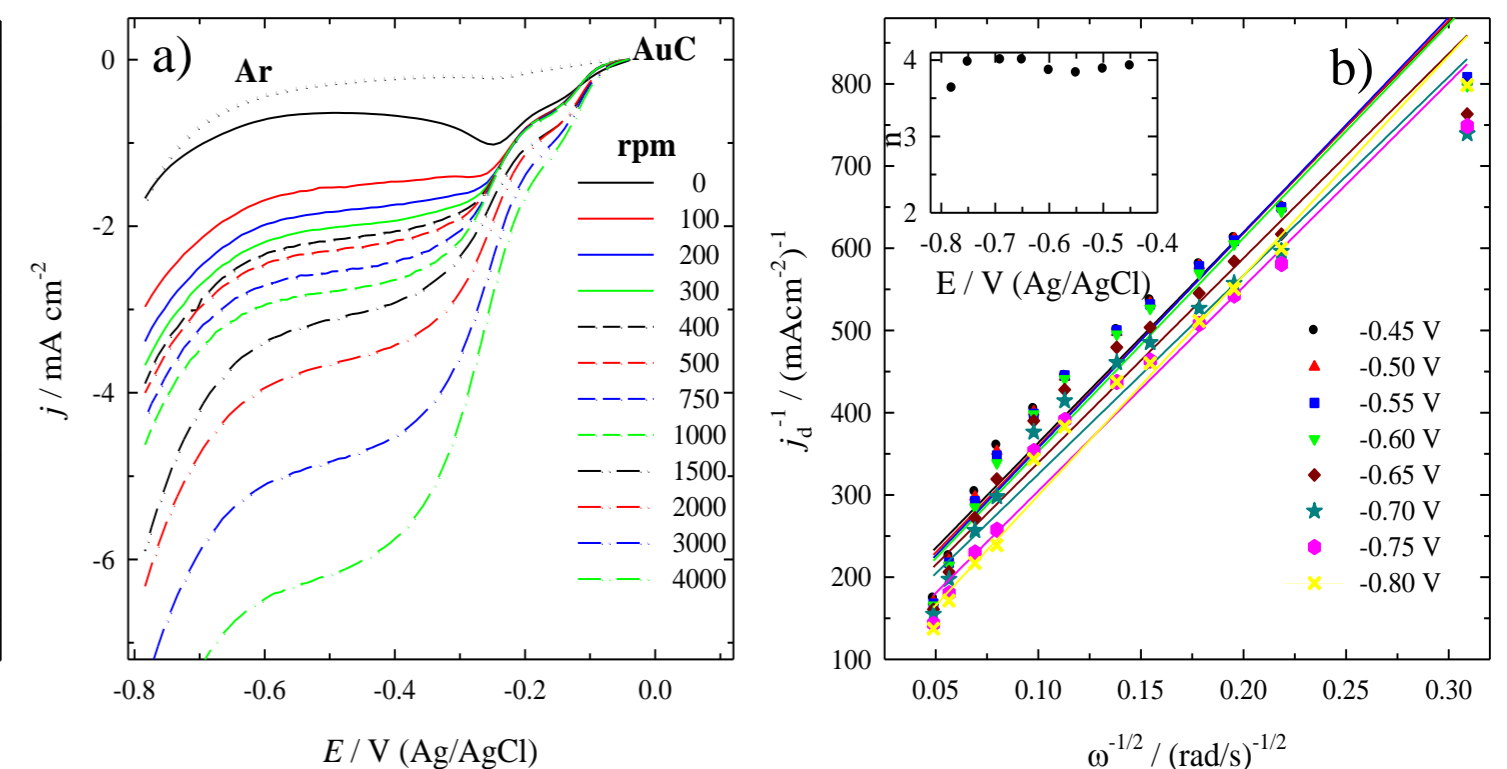


Fig. 7. LSV curves of Au/C catalysts obtained at different rotating rates in the O₂-saturated 0.1 M KOH solution at a scan rate of 10 mV s⁻¹ (a) and Koutecky-Levich plots for ORR in O₂-saturated 0.1 M KOH solution at different potential of the same catalyst (b).

Koutecky-Levich equation:

$$\frac{1}{j} = \frac{1}{j_d} + \frac{1}{j_k} = \frac{1}{0.62nFD^{2/3}v^{-1/6}C_{\text{bulk}}\omega^{1/2}} + \frac{1}{j_k}$$

F – Faraday constant
n – number of electrons
j_k – kinetic current density

D – O₂ diffusion coefficient
C_{bulk} – O₂ bulk concentration
ν – kinematic viscosity of the electrolyte