

Fig. 4. Cyclic voltammograms on carbon electrode in (a) 0.1 M HCl and (b) 0.1 M HCl + 100 mg·L⁻¹ HAuCl₄ of various scan rates: 5, 10, 20, 40 and 50 mV·s⁻¹.

Figure 4b demonstrates cyclic voltammograms of a gold-containing electrolyte and visible cathodic current peaks. However, at relatively high potential scan rates (20–50 mV·s⁻¹), cathode current peaks are not observed, thus indicating a high surface area of the carbon electrode that does not have time to be fully charged during short measurement times. In this regard, to detect current peaks (j_{pc}), low potential scan rates of 1 mV·s⁻¹ to 10 mV·s⁻¹ were selected. As can be seen in Fig. 5, at low electrode polarization rates, cathodic current peaks are clearly visible.

The presence of cathodic current peaks will make it possible to determine the kinetic parameters of the reaction in case if the compensation of charge-discharge currents of the electric double-layer is correct. The linear dependence j_{pc} vs. $v^{1/2}$ (Fig. 5 Inset) was also determined from the voltammograms of the carbon electrode and the diffusion coefficient of Au³⁺ ions was equal to 56.0 cm²·s⁻¹·g⁻¹. The increased value of the diffusion coefficient of gold ions during the electroreduction of AuCl₄⁻ ions on the carbon electrode is four orders of magnitude higher than that on the gold electrode.

The overestimated value of the diffusion coefficient in this case (in aqueous electrolytes, the diffusion coefficient of ions varies in the region of 10⁻³ cm² s⁻¹ ÷ 10⁻⁷ cm²·s⁻¹) is explained by the high specific surface of the activated electrode and the calculated apparent diffusion coefficients need to be adjusted for the mass of the carbon material. In addition, the voltammogram (Fig. 5) shows that the potential difference (ΔE_p) of the anode (E_{pa}) and the cathode peak (E_{pc}) is approximately 60 mV less than that of the gold electrode and the cathode currents are ~ 50 times higher, respectively.

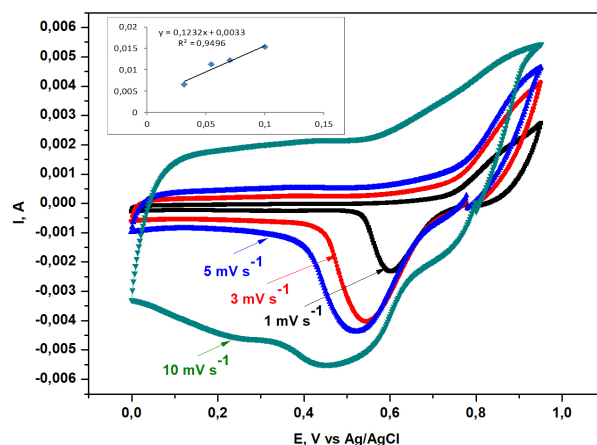


Fig. 5. Cyclic voltammograms on carbon electrode in 0.1 M HCl + 100 mg·L⁻¹ HAuCl₄ of various scan rates: 1, 3, 5 and 10 mV·s⁻¹.

This indicates the catalytic effect of this electrode, which has a reducing property and has a more negative stationary potential (system consisting of H⁺ | activated carbon) than the system consisting of AuCl₄⁻ | Au, which is given above.

The scanning electron microscopic images of the gold adsorbed carbon surface was carried out to see the existence of the gold particles and their morphology. SEM images of the carbon electrode surface after deposition are represented in Fig. 6.

In the SEM images, it is clearly seen that the carbon surface is irregular in nature and gold was grown not as a uniform thin film, but as a spherical and prolate (elongated). The smallest gold nanoparticles that could be examined were 100–250 nm in diameter on the surface of the carbon electrode. Submicron gold particles mostly were not grown separately. They are agglomerated and cannot