Fig. 4. Cyclic voltammograms of gold at 298 K on a Pt electrode in 0.1 mol L^{-1} KCl solution with different HAuCl$_4$ contents at a sweep scan rate of 10 mV s^{-1}.

Table 1
The values of the diffusion coefficient of gold ions during electroreduction of gold on the platinum electrode in 0.1 mol L^{-1} KCl solution.

Method	CV			
C $AuCl_4^-$, mg L^{-1}	7.65	23.13	45.34	80.79
D $AuCl_4^-$, 10^{-14} cm^2 s^{-1}	0.15	1.39	5.38	17.06

where i_p is the cathode current of the peak; n is the number of electrons involved in the electrode reaction; A is the area of the electrode, cm^2; F is the Faraday constant, Pendant mole^{-1}; D is the diffusion coefficient of Au^{3+} ions, cm^2 s^{-1}; C is the volume concentration of Au^{3+}, mol cm^{-3}; ν is the potential scan rate, V s^{-1}; R is the gas constant, J mol^{-1} K^{-1}; T is the temperature, K. The diffusion coefficient calculated for aqueous gold solutions is shown in Table 1. It is observed that with an increase in the concentration of gold, the diffusion coefficient increases.

The electrochemical reduction of gold ions occurring on the surface of the carbon adsorbent obtained from RH is limited by diffusion, and this proves the presence of the Randles-Ševčik dependence. The electrochemical stage, i.e. the electron transfer process proceeds quickly, and it should be assumed that the charge transfer rate constant is several orders of magnitude higher than the mass transfer constant.

Next, chronoamperograms of the electroreduction of gold ions on a Pt electrode at various potentials were obtained (Fig. 5). As can be seen from the Fig. 5, gold electroreduction at the potential of 0.6 V does not occur, it proceeds with a limiting diffusion current at potentials of 0.4; 0.2 V. Two regions are clearly visible from the current transient at a constant potential. The region of decrease in the cathode current is due to the diffusion limitation of the process, which is described by the Cottrell law, which is characteristic of non-stationary linear diffusion processes. The limiting current region is described by the following equation [24].

$$i_k(t) = i_d(t) = -nFC_{Au^{3+}}\sqrt{D_{Au^{3+}}/\pi t} \qquad (4)$$

where $D_{Au^{3+}}$ – the diffusion coefficient, cm^2 s^{-1}; t – time, s.

In this region, the effective thickness of the diffusion layer is established, which is constant in time. It is shown from the equation that the value of the limiting current of electrodeposition of gold ions at a constant value of the diffusion layer thickness depends only on the concentration of gold in the volume of the
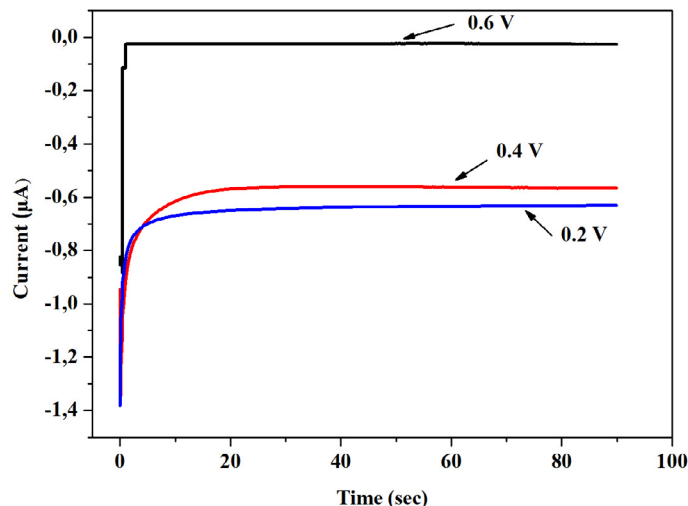

Fig. 5. Chronoamperograms of gold electroreduction in the solution of 80.79 mg L^{-1} HAuCl$_4$ (pH = 1.5) with the addition of sorbent from activated RH at different potentials on a platinum electrode.