

peak with  $T_1 = 523$  K,  $T_2 = 673$  K and  $T_3 = 800 - 810$  K, which corresponds to its adsorption on the surface ( $T_1$ ) and the formation of oxides of Ni and Cu.

The phase composition of the catalyst changes profoundly after thermal treatment of the Ni - Cu - Cr catalyst on Ce/ $\theta$ - $Al_2O_3$  at 1,473 K for 5 h (Figure 4a). There is a slight bend in the curve of the TPR spectrum at 473 K and the main absorption of hydrogen occurs at maximal temperatures both 773 K and 1,073 K, when Cu(Ni) aluminates are reduced. Cu(Ni) $Al_2O_4$  crystals are also fixed (reflex 2.42) according to XRD data. If the reduction temperature of the catalyst in the TPR curves is brought to 1,223 K, the adsorption of oxygen in the unheated Ni - Cu - Cr catalyst proceeds at a temperature  $> 373$  K (Figure 4 b).

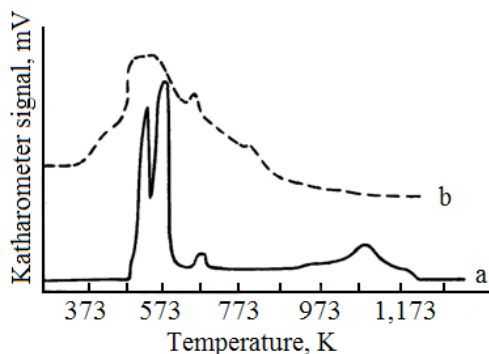


Figure 3: TPR and TPO profiles of the initial Ni - Cu - Cr/2 % Ce/ $\theta$  -  $Al_2O_3$  catalyst: a - TPR profile of the initial catalyst, b - TPO profile after TPR up to 1,225 K

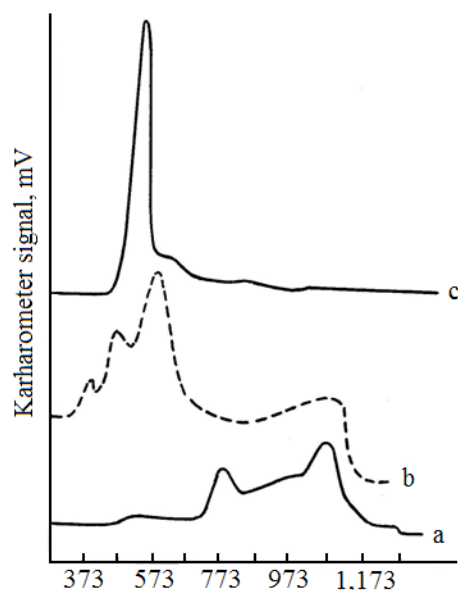


Figure 4: TPR and TPO profiles of the Ni - Cu - Cr/2 % Ce/ $\theta$  -  $Al_2O_3$  catalyst: a - TPR profile of the initial catalyst, b - TPO profile of catalyst reduced up to 1,223 K, c - TPR profile of catalyst after treatment in oxygen to 973 K,  $T = 1,473$  K, 5 h

Subsequent temperature-programmed reduction of catalyst indicates the absorption of hydrogen only in the form of a single peak (Figure 4b), which means that a mixture of Ni(Cu) oxides is regenerated from its aluminates, which are reduced at 523 K.

According to TPD and TPR data, the Ni - Cu - Cr catalyst is a solid solution of copper and nickel oxides with chromium incorporated in it, on the surface of which superstoichiometric surface of oxygen is adsorbed with  $E_{des} = 88 - 89$  kJ mol $^{-1}$ , which easily interacts with reducing agents. TPD curves and temperature programmed oxidation data indicate its presence in the catalyst. Under the influence of high temperatures (due to overheating up to 1,473 K during the oxidation of methane and other alkanes), less active Ni and Co aluminates, with the exception of mixed oxides, are formed in the catalyst in an oxidizing atmosphere.