Nanocatalyst for carbon monoxide oxidation based on palladium(II), copper(II) salts and carbon fiber material

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Carbon monoxide is dangerous for the environment and humans. It is known that carbon monoxide is oxidized to CO_2 only in the presence of catalysts. Analysis of research showed that Wacker-type metal-complex catalysts deposited on various carriers demonstrate stable protective properties and may be promising for the respiratory protective equipment use. The basic components of such catalysts are palladium(II) and copper(II) salts, as well as some additives supported on various carriers. Silica, alumina, activated carbons and carbon fiber materials (CFM), as well as natural minerals such as tripoli, clinoptilolite, mordenite, and bentonite are used as carriers. The carrier is not an inert support and affects the mechanisms of surface complexes formation, as well as the oxidation state of palladium in the case of carbon carriers. The phase composition, textural, protolytic properties, and activity of catalysts for the carbon monoxide low-temperature oxidation based on two series of non-woven carbon fiber material samples CFM-I and CFM-II, and K_2PdCl_4, $Cu(NO_3)_2$, KBr basic components were studied in this work. Catalysts and CFMs were studied by XPA, adsorption/desorption of nitrogen and water, pH-metry, atomic absorption spectrophotometry.

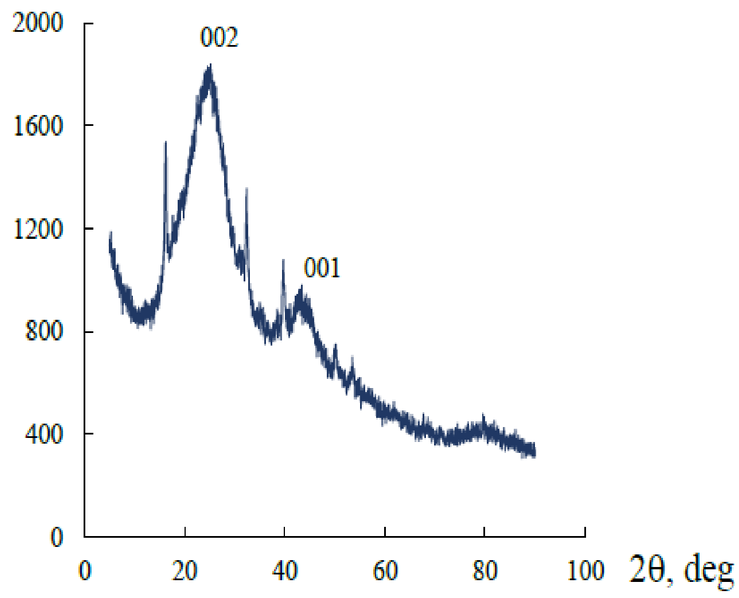

Fig.1. X-ray diffraction patterns catalyst Pd(II)-Cu(II)/CFM-II

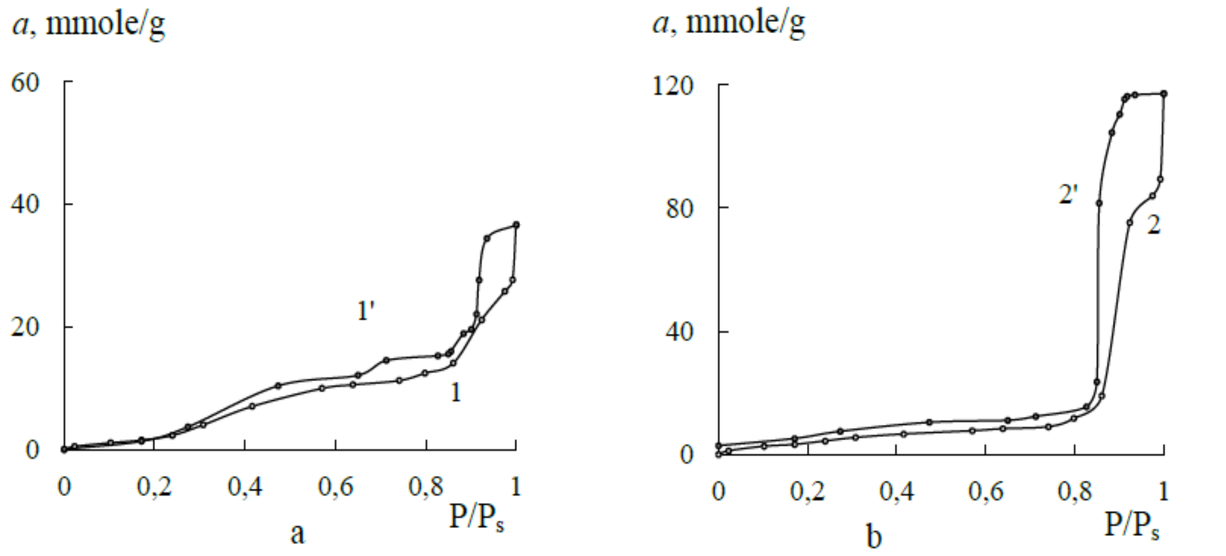

Fig. 2. Adsorption isotherms (1, 2) – desorption (1, 2) water vapor with samples CFM (a) and Pd(II)-Cu(II)/CFM (b) at temperature 20 °C

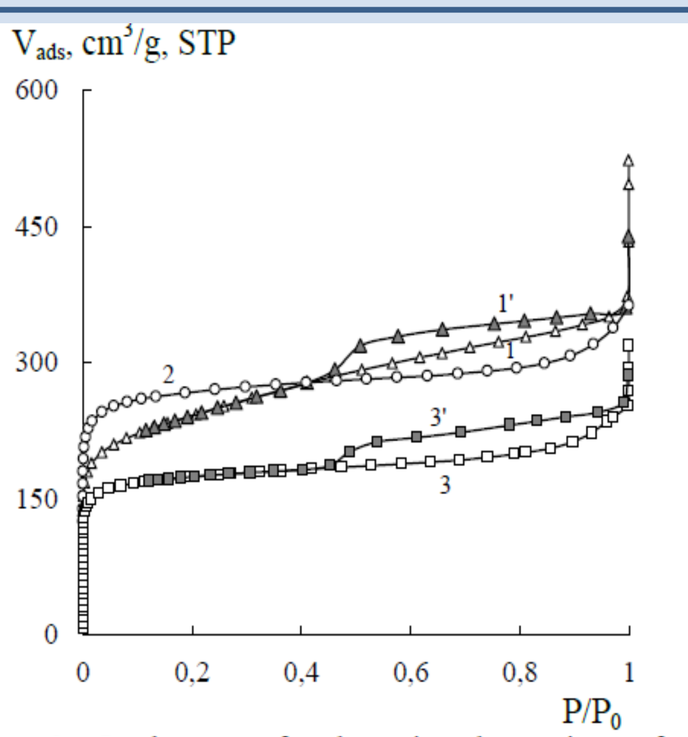

Fig. 2. Isotherms of adsorption-desorption of nitroge samples: 1 – CFM-I; 2 – CFM-II; 3 – Pd(II)-Cu(II)/CFM-II

Table 1

Structural and adsorption characteristics of CFM samples and Pd (II)-Cu (II)/CFM-II catalyst

Sample	BET			Dubinin-Radushkevich (DR)			Horvath and Kawazoe (HK)		
	a_m, mmol/g	C	S_{sp}, m^2/g	a_m, mmol/g	V_{mi}, cm^3/g	$S_{мит}$, m^2/g	d_m / d_{max}, nm	V_c, cm^3/g	S_c, m^2/g
CFM-I	9.06	605.5	883.7	9.1617	0.3174	893.8	0.6159 / 0.942	0.4032	1185.0
CFM-II	10.46	-2005	1020.9	11.348	0.3931	1107.1	0.5431 / 0.4494	0.4223	1408.2
Pd(II)-Cu(II)/ CFM-II	6.96	1188.8	679.49	7.4115	0.2567	723.05	0.5851 / 0.5606	0.2774	824.0

The catalysts were tested in the range of carbon monoxide initial concentrations from 50 to 300 mg/m³ with an effective contact time of the catalyst with the gas-air mixture from 0.12 to 0.50 s. Catalysts provide air purification from CO to concentrations below MPC_{CO} (20 mg/m³) and can be used in respiratory devices.

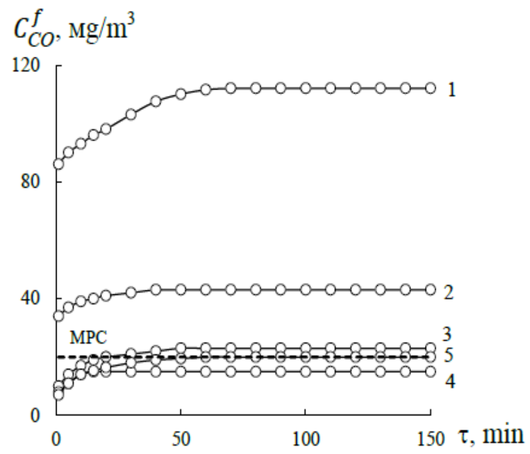

Fig. 4. Change in C^f_{CO} over time with varying the number of Pd(II)-Cu(II)/CFM-I catalyst layers from one to four (curves 1-4); five-layer Pd(II)-Cu(II)/CFM-II catalyst (curve 5).

Table 2

Influence of the Pd(II)-Cu(II)/CFM catalyst-bed configuration on its activity in the oxidation of carbon monoxide with air oxygen

C^i_{CO}= 300 mg/m³; U = 2.1 cm/s

Number of layers	h, cm	τ_{ef}, s	m_{ef}, g	C^f_{CO}, mg/m³ stationary mode	η_{st}, %
Pd(II)-Cu(II)/CFM-I					
1	0.26	0.12	0.17	112	63
2	0.52	0.25	0.34	43	86
3	0.78	0.37	0.51	23	92
4	1.04	0.50	0.68	15	95
Pd(II)-Cu(II)/CFM-II					
4	0.76	0.36	0.64	47	84
5	0.95	0.45	0.80	20	93