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Oxidation of diesel soot on binary oxide CuCr(Co)-based monoliths

Sergiy O. Soloviev⁎, Andriy Y. Kapran, Yaroslava P. Kurylets

L.V. Pisarzhevskii Institute of Physical Chemistry, National Academy of Sciences of Ukraine, 31 Prospekt Nauky, 03028 Kyiv, Ukraine

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ABSTRACT

Binary oxide systems (CuCr2O4, CuCo2O4), deposited onto cordierite monoliths of honeycomb structure with a second support (finely dispersed Al2O3), were prepared as filters for catalytic combustion of diesel soot using internal combustion engine’s gas exhausts (O2, NOx, H2O, CO2) and O3 as oxidizing agents. It is shown that the second support increases soot capacity of aforementioned filters, and causes dispersion of the particles of spinel phases as active components enhancing thereby catalyst activity and selectivity of soot combustion to CO2. Oxidants used can be arranged with reference to decreasing their activity in a following series: O3 ≫ NO2 > H2O > NO > O2 > CO2. Ozone proved to be the most efficient oxidizing agent: the diesel soot combustion by O3 occurs intensively (in the presence of copper chromite based catalyst) even at closing to ambient temperatures. Results obtained give a basis for the conclusion that using a catalytic coating on soot filters in the form of aforementioned binary oxide systems and ozone as the initiator of the oxidation processes is a promising approach in solving the problem of comprehensive purification of automotive exhaust gases at relatively low temperatures, known as the “cold start” problem.

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Introduction

Removal of soot particles, which do not burn on the three-way catalysts (TWC), based on platinum group metals, belongs to the most important problems in operation of diesel engines. Purification of the gas exhausts from solid macroparticles, the basic fraction of which is elemental carbon with core diameter less than 40 nm, is a complicated problem and still far from the optimum solution (Kašpar et al., 2003; Van Setten et al., 2001; Farrauto and Voss, 1996). Technologies of entrapping and removal of macroparticles of carbon from automotive gas emissions are quite in demand and continue to be the subject of intensive researches in context of practical application.

Conventional soot filters made of a metal wire, ceramic foams, inorganic fibers etc., have a number of the unsatisfactory features connected with the complexity of regeneration process. The most rational decision of a problem of solid macroparticles’ removal is combination of the filter and an oxidant of the soot in one component (Van Setten et al., 2001; Ciambelli et al., 2002a, 2002b; Banús et al., 2010). Such a combination is achieved by depositing a catalytic coating onto the soot filters’ surface to yield an ultimately catalyzed diesel particulate filter (CDPF). Various oxide systems can be used as a catalytic coating: individual oxides of transition metals or their mixtures (Liu et al., 2002) including those modified by alkali and platinum group metals (Pisarello et al., 2002; Obuchi et al., 2000; Setiabudi et al., 2004) as well as complex oxide compositions with a low eutectic melting point (Van Setten et al., 1999; Badini et al., 2000).

The major tasks in designing the catalytic coatings for CDPF consist in achieving an efficient contact between the soot particles and catalyst surface (Liu et al., 2002; Pisarello et al., 2002) as well as lowering the oxidation temperature of finely dispersed carbon (Van Setten et al., 2001, 1999). The former task can be solved by use of soot filter frameworks with a highly

⁎ Corresponding author. E-mail: soloviev@inphyschem-nas.kiev.ua (Sergiy O. Soloviev).

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High activity in the oxidation of finely dispersed carbon is observed for the complex oxide systems — eutectic mixtures with low melting points (e.g., $\mathrm{Cs}_2\mathrm{MoO}_5/\mathrm{V}_2\mathrm{O}_5$) (Van Setten et al., 1999; Saracco et al., 1999) or perovskite structures with alkali promoters $\mathrm{K}_2\mathrm{O}/\mathrm{Co}/\mathrm{La}_2\mathrm{O}_3$, $\mathrm{La}_2\cdots\mathrm{K}_2\mathrm{CoO}_3$, $\mathrm{La}_2\cdots\mathrm{K}_2\mathrm{MnO}_3$, and $\mathrm{La}_2\cdots\mathrm{K}_2\mathrm{FeO}_3$ (Miró et al., 2000; Wang et al., 2012), which facilitate an intensive combustion of the soot at the temperatures of 280-400°C. Binary systems of the spinel type (copper chromite and cobaltite) proved to be the most active among aforementioned composites. These catalysts are practically competitive to the mixtures with a low eutectic melting point ($\mathrm{K}/\mathrm{Co}/\mathrm{La}_2\mathrm{O}_3$, $\mathrm{Ba}/\mathrm{Co}/\mathrm{MgO}$, $\mathrm{K}/\mathrm{Co}/\mathrm{Co}_2\mathrm{O}_4$) with reference to activity in the soot oxidation whereas surpass substantially the individual oxides ($\mathrm{MoO}_3$, $\mathrm{V}_2\mathrm{O}_5$, $\mathrm{Fe}_2\mathrm{O}_3$, $\mathrm{CuO}$) applied on different supports ($\mathrm{SiO}_2$, $\mathrm{SnO}_2$, $\mathrm{ZrO}_2$) (Liu et al., 2002).

It should be mentioned that compositions based on platinum metals belong to the most efficient catalysts of soot oxidation. Their activities as well as activities of systems based on alkali metal oxides can be increased sufficiently by rare earth element oxides (REEO), first of all $\mathrm{CeO}_2$, as dopants (Bueno-López et al., 2007; Aouad et al., 2007; Aneggi et al., 2008; Gross et al., 2009; Shimokawa et al., 2012). Promoting effects in this case can be attributed to decrease in $\mathrm{Me}_2$O binding energy and increase in a surface concentration of mobile oxygen. Besides, REEO modifying additives are capable of raising thermostability of catalysts on the basis of transition metal oxides (Dhakad et al., 2008).

As the soot oxidants, molecular oxygen and nitrogen oxides are used most often (Zawadzki et al., 2011; Zhang et al., 2013). The water vapors can also be an efficient oxidizing agent — the reaction of $\mathrm{C} + \mathrm{H}_2\mathrm{O}$ proceeds with an appreciable rate at temperatures slightly exceeding 200°C (Liu et al., 2002). Moreover, the concentration of water vapors in the internal combustion engine (ICE) exhausts is much higher than that of $\mathrm{O}_2$ and $\mathrm{NO}_x$.

The water vapors, being one of the dominant motor fuel combustion products with much higher concentration in the internal combustion engine (ICE) effluent gases than that of $\mathrm{O}_2$ and $\mathrm{NO}_x$, can also be efficient oxidant of the soot — the reaction of $\mathrm{C} + \mathrm{H}_2\mathrm{O}$ proceeds at an appreciable rate at the temperatures above 200°C (Liu et al., 2002). Water and carbon dioxide belong to the main products of engine fuel combustion: their concentrations in exhaust gases are much higher as compared with those of other oxidants; besides, reaction of water gas at appreciable rate proceeds already at temperatures slightly exceeding 200°C (Liu et al., 2002). It should be mentioned that one of the most promising oxidants is ozone, which can be decomposed (in the presence of heterogeneous catalysts) with the formation of atomic oxygen with high reactivity. Preliminary treatment by ozone was shown to reduce temperature of burning of diesel soot on a surface of the catalysts containing oxides of copper, cerium and aluminium (Bokova et al., 2003).

The reaction of diesel soot oxidation by ozone is logical to expect as proceeding at relatively low temperatures, when other oxidants are inefficient (Gómez-Serrano et al., 2002).

In the present work, soot oxidation by ozone as well as $\mathrm{O}_2$, $\mathrm{H}_2\mathrm{O}$, $\mathrm{CO}_2$, $\mathrm{NO}$, and $\mathrm{NO}_2$ (components of ICE’s gas exhausts) was studied on copper chromite and cobaltite as catalytic coatings supported on cordierite monolithic matrices. Noteworthy is that these reactions underlie processes of neutralization of combustion products with much higher concentration in the ICE’s exhaust gases than that of $\mathrm{O}_2$ and $\mathrm{NO}_x$, can also be efficient oxidant of the soot combustion at the temperatures of 280-400°C.

Relative strength concerning crushing along the channel axes at 50 MPa, and across the channel axes at 20 MPa.

The CDPF samples were prepared via successive application of alumina ($\gamma\mathrm{Al}_2\mathrm{O}_3$) as a substrate (second support) and copper chromite or cobaltite on the cordierite matrix followed by annealing to form the required phases of the active components. The substrate (8–9 wt.% $\gamma\mathrm{Al}_2\mathrm{O}_3$) was deposited onto a surface of cordierite blocks by impregnation from aquatic salt solutions of $\mathrm{Al}(\mathrm{OH})_3/\mathrm{NO}_3\cdot\mathrm{H}_2\mathrm{O}$ and $\mathrm{Al}(\mathrm{NO}_3)_3\cdot9\mathrm{H}_2\mathrm{O}$ with the subsequent drying at temperature of 110°C and calcination at 550°C. The catalyst samples were prepared by the impregnation of $\mathrm{Al}_2\mathrm{O}_3$/cordierite monoliths by aquatic solutions of $\mathrm{Cu(NO}_3)_2\cdot3\mathrm{H}_2\mathrm{O} + \mathrm{Cr}_2\mathrm{O}_3$ or $\mathrm{Cu(NO}_3)_2\cdot3\mathrm{H}_2\mathrm{O} + \mathrm{Co(NO}_3)_2\cdot6\mathrm{H}_2\mathrm{O}$ mixtures at such ratios of their constituents that are necessary for the formation of copper chromite $\mathrm{CuCr}_2\mathrm{O}_4$ or cobaltite $\mathrm{CuCo}_2\mathrm{O}_4$ phases in the course of a heat treatment. After the impregnation procedure, the corresponding samples were dried (110°C) and calcinated (600°C).

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1.2. XRD characterization

X-ray diffractograms of massive copper–chrome and copper–cobalt based samples as well as those, supported on alumina, were recorded by means of BRUKER AXS GmbH D8 ADVANCE in monochromatized (the nickel filter) CuKα radiation ($\lambda = 0.15184$ nm). Ceramic frameworks in this case were not used because of their abnormally intensive signal. The phase composition was analyzed using database PDF-2 2006. The coherent scattering region (CSR — the apparent size of corresponding particles) was calculated by the Scherrer equation as: $L = 0.9\lambda/\Delta\cos\theta$.

1.3. Testing the catalytic properties of soot filters

Sooting of cordierite and CDPF specimens was carried out in a special cassette, the construction of which facilitated the...
treatment of all samples by exhaust gases of the motor stand’s diesel engine of 2DT type (running under load) under uniform conditions for 1.5 hr.

Oxidants of elemental carbon-components of ICE gas exhausts (O₂, NO, NO₂, H₂O, CO₂) and O₃ were used as the following mixtures: O₂ + N₂, O₂ + O₃ + N₂, NO + N₂, NO₂ + N₂, H₂O + N₂, and CO₂ + N₂ at concentrations (vol.%) of O₂ 10.0%, H₂O 1.8%, CO₂ 5.0%, O₃ 0.15%, NO₂ 5.0%, and NO 5.0%, N₂ is balance gas.

Soot combustion processes were studied by means of the temperature-programmed surface reaction (TPSR) technique using a Mac-Ben balance with the chromatography analysis of the gaseous oxidation products (CO and CO₂). The catalyst (ca. 1 g, grain size of 0.5–1.0 mm) was heated at 115°C in an argon flow for 3–4 hr to eliminate adsorbed carbon dioxide and moisture (Pisarello et al., 2002). After completion of the conditioning, the sample was heated in a flow of oxidizing gas mixture while raising the temperature at a rate of 4°C/min in the range of 100–600°C and measuring the sample relative weight loss and the concentration of the gaseous reaction products. To determine the temperature of complete combustion of the soot, oxidation runs were carried out under isothermal conditions also.

2. Results and discussion

2.1. XRD patterns

Fig. 1 presents X-ray diffraction patterns of metal oxide compositions. Structural and dimensional characteristics of corresponding catalytic components are summarized in Table 1.

As constituents of the CuCr based massive sample, phases of copper chromite CuCr₂O₄ spinel of tetragonal modification with the medium particle size of 29 nm as well as chrome oxide Cr₂O₃ (rhombohedral mod., 43 nm) are identified. Within the CuCo massive specimen, identified are crystallites of copper cobaltite CuCo₂O₄ spinel (cub. mod., 30 nm) and copper oxide CuO (monocl. mod., 29 nm). An analysis of the XRD patterns for the CuCr(Co)-based samples, deposited on alumina (X-ray amorphous due to fine dispersivity), also gives a basis for indexing CuCr₂O₄ and CuCo₂O₄ phases with the apparent particle sizes of 17 and 22 nm, accordingly. Comparing the corresponding SCR values leads to the conclusion that the substrate facilitates dispersion of active components’ particles within CuCr(Co)/Al catalysts. Indistinct reflexes of crystal phases of chrome and copper oxides in the diffraction patterns of the supported samples are caused, apparently, by their low contents. This circumstance does not make possible indexing and, accordingly, calculating the corresponding CSR values.

2.2. Oxidation of soot with components of ICE gas exhausts

The results of the tests of soot combustion from the surface of CDPF samples using O₂ as an oxidant are presented in Fig. 2. The maximum weight losses (due to the maximum soot capacity) in the course of the TPSR were observed for the CuCr/Al/cord sample (Fig. 2a). Two peaks in TPSR curves (Fig. 2b) are apparently caused by non-uniform fraction composition of soot in the engine exhaust gases which was also observed in the work (Kašpar et al., 2003). The further increase in temperature (after the second maximum of desorption) was accompanied by a sharp decrease in concentration of gaseous products which indicated the completion of the soot combustion. The similar tendency was observed for the copper cobaltite CuCo/Al/cord catalyst (Fig. 2b) while maxima in desorption curves of CO₂ were shifted to the range of higher temperatures.

Comparison of the CuCo/Al/cord and CuCo/cord samples with a uniform catalytic coating (Fig. 2a, b) shows that combustion of the surface compounds takes place within the range of similar temperatures, and soot capacity of the sample with the second support (CuCo/Al/cord) is considerably higher. The cordierite starting material is characterized by considerably less soot capacity, and an intensive burning of the soot begins at temperatures above 500°C when the regeneration process of the samples with a catalytic coating is practically over.

CO₂ was found to be the only carbon-containing gaseous product for CDPF with copper chromite or cobaltite catalytic coatings. Formation of considerable amounts of carbon monoxide in our tests took place only on the surface of cordierite starting material without a catalytic coating.

Fig. 3 shows TPSR profiles of soot combustion from the surface of CuCr/Al/cord catalyst which make possible to compare the activities of different oxidants in this process.

---

**Table 1 – Structural and dimensional characteristics of CuCr(Co) based compositions.**

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<th>Sample</th>
<th>Indexed phases</th>
<th>Coherent scattering region, nm</th>
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<tbody>
<tr>
<td>CuCr</td>
<td>CuCr₂O₄, tetragonal</td>
<td>29</td>
</tr>
<tr>
<td>CuCr₂O₄</td>
<td>Cr₂O₃, rhombohedral</td>
<td>43</td>
</tr>
<tr>
<td>CuCr/Al</td>
<td>CuCr₂O₄, tetragonal</td>
<td>17</td>
</tr>
<tr>
<td>CuCo</td>
<td>CuCo₂O₄, cubic</td>
<td>30</td>
</tr>
<tr>
<td>CuCo/Al</td>
<td>CuCo₂O₄, cubic</td>
<td>29</td>
</tr>
<tr>
<td>CuCo/O₃</td>
<td>CuCo₂O₄, cubic</td>
<td>22</td>
</tr>
</tbody>
</table>
The catalyst activity in a complex process of soot burning is usually characterized by three temperatures with respect to: onset of the reaction, the highest rate of soot combustion, the completion thereof (Liu et al., 2002). As shown in Fig. 3, temperatures of onset of the reaction with use of NO and NO\textsubscript{2} as oxidants are sufficiently lower than the corresponding temperatures when O\textsubscript{2} was used as an oxidizing agent.

It can be concluded, taking into consideration the positions of major maxima of \textit{СО}_2 desorption in TPSR curves, that at higher temperatures the process of soot burning proceeds the most intensively in the presence of nitrogen oxide (IV), whereas activities of oxygen and nitrogen oxide (II) are substantially lower. The temperature of complete soot combustion in the presence of NO\textsubscript{2} or O\textsubscript{2} is lower by almost 100° as compared to that one in the presence of NO.

The only carbon-containing product in these tests is СО\textsubscript{2}, which implies the following reactions of soot oxidation on CuCr/Al/cord sample (Eq. (1)-(3)):

\[
\text{C} + \text{O}_2 \rightarrow \text{CO}_2 \quad (1)
\]

\[
\text{C} + 2\text{NO}_2 \rightarrow \text{CO}_2 + 2\text{NO} \quad (2)
\]

\[
\text{C} + 2\text{NO} \rightarrow \text{CO}_2 + \text{N}_2. \quad (3)
\]

The soot oxidation by water vapors on copper cobaltite based samples, as can be observed from the Fig. 4, begins at temperatures above 200°. The second support γ-Al\textsubscript{2}O\textsubscript{3} enhances catalyst activity, which is revealed by the shift in the position of the major maximum in the TPSR curve, corresponding to the highest rate of carbon burning, and to the range of lower temperatures. The promoting role of different crystalline modifications of Al\textsubscript{2}O\textsubscript{3} in the carbon conversion on oxide catalysts (Saracco et al., 1999) may be conditioned both by increase in a dispersion degree of the particles of active component (due to the development of porous structure) and an enhancing of water vapor adsorption on Lewis acid sites of the surface.

The major product of the reaction of carbon with water vapors is СО\textsubscript{2}, whereas emission of СО is not intensive — appreciable amounts of carbon monoxide are observed only at maximum reaction rate. It is obvious that a predominant route of the soot oxidation with water vapors in the diffusion layer is the following (Eq. (4)):

\[
\text{C} + 2\text{H}_2\text{O} \rightarrow \text{CO}_2 + 2\text{H}_2 \left( \Delta H^0 = +90.6 \text{ kJ/mol} \right) \quad (4)
\]

collaterally with which at 240–450°C (under temperature conditions of our tests) reaction of water gas with carbon (Eq. (5))

\[
\text{C} + \text{H}_2\text{O} \rightarrow \text{CO} + \text{H}_2 \left( \Delta H^0 = +132 \text{ kJ/mol} \right) \quad (5)
\]

as well as carbon monoxide conversion (Eq. (6))

\[
\text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2 \left( \Delta H^0 = -41 \text{ kJ/mol} \right) \quad (6)
\]

are possible to take place.

Interaction of soot with carbon dioxide — Boudoir reverse reaction (Eq. (7))

\[
\text{C} + \text{CO}_2 \rightarrow 2\text{CO} \left( \Delta H^0 = +172.5 \text{ kJ/mol} \right)
\]
becomes thermodynamically possible only at temperature of 430°C ($K_r = 0.8 \times 10^{-3}$) and at the presence of CuCo/Al/cord catalyst proceeds with an appreciable rate at the temperatures exceeding 500°C (Fig. 4, curve 4).

When comparing temperature profiles for the formation of gaseous products in the reaction of carbon conversion (Figs. 3 and 4), it can be seen that temperatures of soot oxidation with water vapors and other oxidants on studied catalysts are comparable. Therefore, water vapors can be considered as a promising oxidizing agent for diesel soot oxidation.

### 2.3. Oxidation of soot with ozone

Fig. 5 shows TPSR profiles of soot oxidation by ozone in comparison with thereof by molecular oxygen.

As it can be seen, reaction of ozonated oxygen with the soot on a surface of cordierite without a catalytic coating proceeds at the closing to ambient temperatures, whereas appreciable interaction of carbon particles with molecular oxygen takes place only at the temperatures exceeding 250°C (Fig. 5a). Oxidation of soot by O$_3$ on copper chromite based catalyst, displaying high activity in an ozone decomposition reaction, proceeds more vigorously as compared with the soot combustion on aforementioned Cord sample. This fact is exhibited by shift of the first maximum in the corresponding TPSR curve in area of lower temperatures (Fig. 5b).

Noteworthy is that CO$_2$ was monitored as the only carbon containing product of soot oxidation with ozone.

Above 180°C the finely dispersed carbon oxidation with molecular and ozonated oxygen takes place practically in the same temperature range on both Cord and CuCr/Al/cord samples which is explained by high rate of ozone dissociation under these conditions. The unreacted ozone practically completely dissociates, forming molecular oxygen, and is not detected in the outlet gases.

Apparently, the first stage of process is ozone dissociation (Eq. (8)) on an active site (designated as $[]$) of catalyst surface resulting in the adsorbed atomic oxygen with high reactivity (Rakitiskaya et al., 1999):

$$ O_3 + [\rightarrow O_2 + [O]. $$

This adsorbed oxygen reacts with soot producing carbon monoxide (Eq. (9)),

$$ C + [O] \rightarrow [CO] $$

followed by its subsequent fast oxidation to carbon dioxide (Eq. (10)),

$$ [CO] + [O] \rightarrow [CO_2 + 2[]] $$

which is an ultimate product of interaction of elemental carbon with O$_3$.

Ozone, which has not reacted, completely dissociates with formation of molecular oxygen (Eq. (11)),

$$ O_3 + [O] \rightarrow [O_2 + [O]. $$

and is not registered (O$_3$) in outlet gas. At elevated temperatures (above 180°C), owing to increase in oxygen recombination rate (Eq. (11)), oxidation of finely dispersed carbon with molecular oxygen and ozone oxygen proceeds practically in a same temperature range.

---

![Fig. 4](image1.png)

**Fig. 4** – Temperature dependences of gaseous products’ evolution from the surface of CuCo/Al/cord (lines 1, 2, 4) and CuCo/cord (line 3) catalysts during soot oxidation with H$_2$O (lines 1–3) and CO$_2$ (line 4).

---

![Fig. 5](image2.png)

**Fig. 5** – Combustion of the soot from the surface of cordierite sample without catalytic coating (a) and CuCr/Al/cord (b) using O$_2$ and (O$_2$ + O$_3$) as oxidants.
Table 2 shows the summarized results of the tests of soot combustion processes on the surface of copper chromite based catalyst under isothermal conditions which allow us to quantitatively assess the extent of catalyst regeneration at different temperatures.

As it can be seen, the ozone facilitates a high extent of burning the soot even at 100–150°C, whereas use of other oxidants leads to shift of the onset of the process toward the higher temperature range: e.g., in the presence of NO2 the soot combustion at an appreciable rate proceeds at 160°C, while in the presence of O3 or NO— at 180°C.

Thus, the activity of oxidants used decreases in the following row:

\[ \text{O}_3 \gg \text{NO}_2 > \text{H}_2\text{O} > \text{NO} > \text{O}_2 > \text{CO}_2. \]

Noteworthy is that CO2 was found to be a prevailing gaseous carbon-containing product of diesel soot oxidation on the filters with copper chromite or cobaltite as a catalytic coating. Formation of considerable amounts of carbon monoxide took place only on the surface of the cordierite starting material samples having no catalytic coating. Low concentrations of CO were also registered in gaseous products of carbon conversion with water vapors on CuCo2O4/Al/cord sample.

Therefore, catalysts designed here proved to be highly selective with respect to CO2 in the process of soot combustion. The finely dispersed Al2O3 as a second support causes dispersion of the crystallites of spinel phases as active components, enhances filter soot capacity and increases the soot combustion selectivity to CO2.

The activity of catalysts in the reaction of finely dispersed carbon oxidation is often connected with the “surface mobility” of the oxide coating, qualitative characteristic of which is the melting point of the oxide or its saturated vapor pressure (Van Setten et al., 1999; Liu et al., 2002). The mechanism of the reaction of catalytic combustion is described in detail in the works of Liu et al. (2002), Pisarello et al. (2002), and Miró et al. (2000)). Using the high frequency CO2 pulsation method, which allows us to evaluate the dynamics of formation and destruction of surface carbonates at different temperatures, the work of Miró et al. (2000) shows that in the presence of catalysts, based on transition metal oxides, the reaction proceeds via successive stages of oxygen activation, formation and destruction of surface carbonates, and reoxidation of the surface. Thus, the determining characteristics of catalysts for given process are the combination of adsorption and redox properties of the surface (Van Setten et al., 2001; Miró et al., 2000). In present work, regulation of adsorption properties was achieved by depositing Al2O3 as the second support, while regulation of redox properties—via using the oxidants with high reactivity (NO2, O3).

Water vapors, which are similar to O2 and NO concerning activity, proved to be an efficient oxidant of finely dispersed carbon in the presence of the designed here catalysts. It is expected that the regeneration of soot filters with a catalytic coating, based on copper chromite or cobaltite, is possible to conduct even at the temperatures of ICE effluent gases.

Using the binary oxide systems as the catalytic coatings for CDPFs and ozone as initiator of the toxic components’ oxidation we consider as promising approach in solving the problem of the “cold start” (Farraruto and Heck, 1998)—comprehensive waste gases’ purification at relatively low temperatures.

### 3. Conclusions

Binary oxide systems, prepared via consecutive deposition of second support (finely dispersed Al2O3) and catalytic coating (CuCr2O4 or CuCo2O4) onto cordierite monoliths of honeycomb structure, are shown to be highly efficient in removal of diesel soot from automotive gas exhausts using ICE’s effluents (O2, NO2, H2O, CO2) and O3 as oxidizing agents.

The determining characteristics of the catalysts, ensuring absorption and subsequent combustion of the soot, are the combination of adsorption and redox properties of the surface.

Alumina as the second support was shown to increase soot capacity of CDPFs, and cause dispersion of the particles of spinel phases as active components enhancing thereby catalyst activity and selectivity of soot combustion to CO2.

Oxidants used can be arranged with respect to decrease in their activity in a following series: \[ \text{O}_3 \gg \text{NO}_2 > \text{H}_2\text{O} > \text{NO} > \text{O}_2 > \text{CO}_2. \] Ozone proved to be the most efficient oxidizing agent: the diesel soot combustion by O3 occurs intensively on the copper chromite based catalyst even at closing to ambient temperatures.

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