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ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF NEW CARBON SOOTS

Objectives. To obtain skills in the investigation of the main characteristics of carbon materials, and compare them with the commercial analogue «Pure Black».

Methods and means of research. Optical microscopy, pH-metry, determination of the factor of structure formation, electrical resistance, method of determining the angle of wettability, the method using a four-electrode cell.

Research results. When composite materials are manufactured as a conductive or reinforcing component, soot is widely used. Properties of soot depend on the type of initial organic material, the method of its thermal decomposition, the method of precipitation of the formed carbon suspension. The main characteristics of the resulting soot are the degree of graphitization, the dispersion of particles, the structure, the degree of oxidation, ash content. Focusing on these properties, the question of the expediency of using a particular type of such material in the manufacture of a product is solved. So for electrode composites of lithium ion batteries are widely used high-purity electroconductive black «Pure Black» firm:

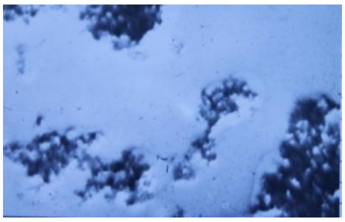
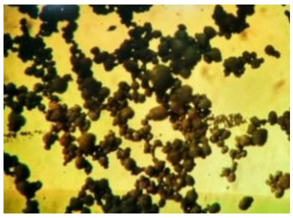
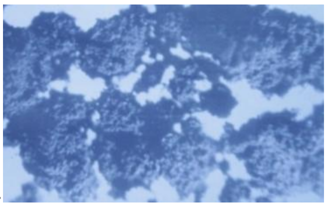
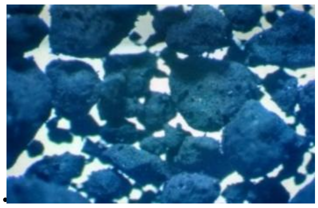
a).  b). 

Fig.1 Pure Black Soot Structure

(a - electron microscopy, magnification x80000; b - optical microscopy)

Visible smallest particles of size ~ 45 nm, which form various chains. These primary structures are joined together in sufficiently loose aggregates.

a).  b). 

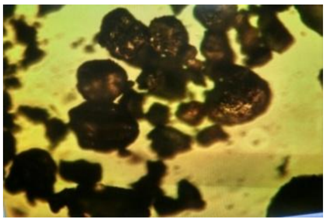
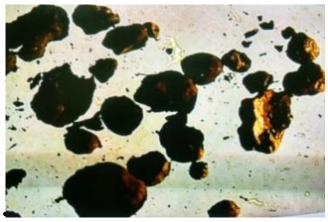
c).  d). 

Fig.2 Photos of aggregates of granulated soot: a - RV; b - number 2; c -№3; d - №330; (x40)

The ability of the soot particles to form a structure is estimated by their oil absorption and has a significant effect on the electrical conductivity of the system.

For the convenience of transportation, the resulting loose soot can be granulated using an organic binder (Fig.2).

Before making composite materials, granular soot can be dispersed. The degree of dispersion in most depends on the electrical conductivity and strength of the composite. It turned out that the conditions of dispersion (time, mixing speed, viscosity of the medium) for each soot are individual, because they have different density, strength. It is also known that it is easier to disperse oxidized soot. The oxidation of the particles depends on their wettability, and in the future, and the interaction with the binding. Determining the angle of wetting of carbon materials is difficult, because even pressed at a pressure of 20 t/cm^2 they, despite the mirror surface, can absorb water.

If you pour carbon material on a glass and place a drop of water on it, then the drop quickly dampens the glass and loses its shape. Therefore, we propose to preliminarily apply a thin layer of oil to the glass, and then pour soot on it. Examples of wettability of some soot water explored are shown in Fig.3.

a) b). c).

Fig. 3 Drops of water on the surface of soot (a - PB, b - CHP; c - soot №330)

The most hydrophobic black soot was Pure Black soot. Probably this is due to the small amount of oxygen-containing functional groups in it (pH of water extraction 7.5) and low content of adsorbed water (mass loss at burning 400ºC for 3 hours was only 0.72%.

Taking into account the hydrophobicity of the soot analyzed, their dispersion was carried out in various media (Fig.4).

a). b). c).

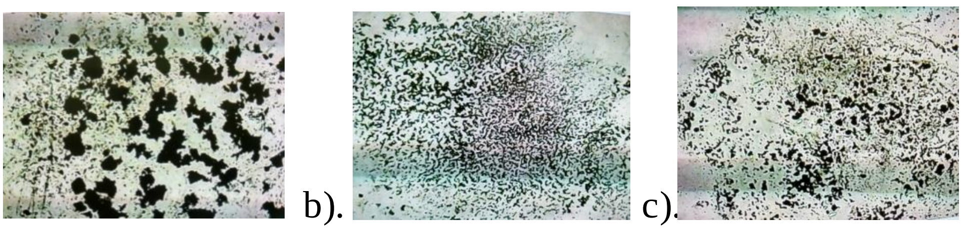


Fig.4. Dispersion of soot RV in liquids of different polarity (a - water; b - alcohol; c - hexane)

A similar effect was observed with the dispersion of other soot. It should be noted that the density (hardness) is so different, which requires their individual modes (temperature, time, viscosity of the medium), their dispersion. The structure of the structure and the possible content of mineral impurities in soils can be estimated by calcining for 3 hours at a temperature of 900ºC. The most amorphous was soot «Pure

Black» (completely burnt out), and the most graphitized – soot №3. The conducted experiment allowed to detect in them the presence of impurities that do not belong to carbon (Fig.5).

Fig. 5 Crucibles with soot after firing

After burning samples of dry soot at 900ºC for 3 years, we managed to achieve the following results: PB completely burned out; Soot №2 burned not completely, on the surface formed a white precipitate; Soot №3 burned out on one third of its mass and, unlike other soot, its surface is absolutely pure; On the soot from the tires, too, a precipitate was formed, but from two layers, one layer of white color, the other – with a greenish tinge; In the soot at number 220 on the surface formed a brown precipitate, and in soot at number 330 – yellow; Soot CHP changed the color in the upper layer from gray to luster and solidified. All this testifies to the presence of impurities in soot.

Table 1.

№	**Parameters**	**PB**	**C65**	**№2**	**№3**	**CHP**	**№220**	**№330**	**tires**
1	Bulk density, g/cm^3	0,110	0,160	0,164	0,296	0,940	0,367	0,382	0,289
2	Oil content, ml/h	3,8	9,4	7,9	3,2	0,6	3,0	2,3	0,9
3	pH	7,5		8,8	8,2	8,0	8,0	7,3	7,4
4	Weight loss 400ºC,%	0,72	0,15	28	7	0,74	14	2,7	34
5	Weight loss 900ºC, %	100	100	94	67	20	56	47	63
	Specific	77,453	6,280	15,612	50,240	-	37,680	35,582	-

6	resistance, kOm ·m								
7	Soaking angle, º	141	110	72	75	70	55	67	104

• Pure Black – Graphite Soot (Superior Graphite Co USA);

• № 2 – partially graphitized carbon black (American Energy Technologies Company, USA)

• № 3 – Graphitized Carbon (American Energy Technologies Company, USA)

• № 220, №330 and tires – are standard domestic soot from Kremenchug plant of technical carbon;

• CHP – waste from the production of thermal power plants working on anthracite «Their utilization – an environmental problem»;

• C65 – soot from a shell of coconut (Timcal, Switzerland).

The electrical conductivity of self-densely-ethanol granulated soot was estimated by 4-electrode method.

Conclusions. Methods of research of physical and chemical parameters of carbon materials have been mastered. A comparative analysis of the basic characteristics of new soot relative to the commercial soot «Pure Black», which is widely used as an electroconductive additive, was carried out:

a) the closest according to parameters of «Pure Black» is the soot №2, which is far ahead by the electric conductivity and structure of «Pure Black». But in contrast to it, small amount of ash residue is detected;

b) when dispersing soot in a liquid medium, it is desirable to use ethanol (low molecular weight alcohols);

c) a large variety of inorganic substances (primarily iron oxides) and various forms of particles, in our opinion, are of interest in the manufacture of composite materials of special purpose.

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THE BIGGEST PROBLEMS FACED BY A GRAPHIC DESIGNER

There are, undoubtedly, advantages and disadvantages in every profession. Everybody certainly has some difficulties at work sometimes even if it is his dream job. Being a graphic designer is not an exception. Unfortunately, a lot of people do not consider being a designer/artist/illustrator a real profession. That is why it would be really helpful to me and other people including the ones not interested in this subject to listen to these real life challenges in order to understand their profession better.

Purpose and objectives: to highlight the most common problems the graphic designer faces in reality and to draw the attention to the job difficulties of the professional in the sphere of art.

A lot of young artists who dream about becoming a designer romanticize this profession a lot. Yes, there is a great deal of wonderful things and positive aspects of working as an artist. But the reality is not so enjoyable after all. There are some issues about working as a designer that only a real designer can understand.