PROTECTION OF SECURITIES USING FULLERENES

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Introduction

After discovery of fullerenes in 1985 many scientists participating in their investigations asked themselves about possible applications of these expensive objects. When the arc synthesis of fullerenes was discovered by W. Kratschmer, there appeared especially many results of research on the use of fullerenes in different fields of science and technique. This method allowed the decrease in the cost of fullerenes in hundreds times what made them available for many investigators. At present it is impossible to describe in one article the fields in which many enthusiasts try to apply fullerenes.

Authors of the work presented have attempted to introduce fullerenes into the composition of securities for their protection [1-23].

Experimental

The fullerenes used were prepared in laboratory 67 in Institute for Problems of Material Science of National Academy of Sciences of Ukraine. Fullerenes were prepared by electric arc graphite sputtering in helium. Operation mixtures were treated on UZDN-1 Y4.2 ultrasonic apparatus at 22 kHz. Samples were analyzed on a scanning electron microscope.

Trial paper mouldings were prepared on the experimental apparatus at the department of ecology and paper in National Technic University of Ukraine "Kiev Polytechnic Institute". In experiments sulphate white cellulose from softwood (l=3-5 mm), hardwood (l=0.7-1.2 mm) and cotton pulp (l=5-7 mm) were used.

Results and discussion

We have considered two types of fullerene-containing cellulose: 1) exofullerized cellulose (C_{exo}); 2) endofullerized cellulose (C_{endo}).

The first variant involved precipitation of fullerites in the nanodispersed state on the surface of cellulose fibers.

The second method involved introduction of fullerenes into cellulose fibers followed by removing the solvent and conversion of fullerenes in the solid state into the fiber bulk.

Moreover, we have considered two techniques for fullerene introduction into the paper as final product. The first one consisted in synthesis of fullerized cellulose and its introduction into the initial stock. The second one consisted in direct introduction of fullerenes into the initial stock during the technological process.

The first technique provides preliminary synthesis of fullerene-containing cellulose with the certain parameters specified beforehand. In the second case it was necessary to convert fullerenes in the water-soluble state, and then, when paper was formed, to convert them in the initial state.

Fig.*a,b,c,d* show microphotographs of the paper containing endofullerized cellulose fibers. Fullerite crystals are absent on the external surface of fibers. Fig.*e* shows the photograph taken on an optical microscope and a color film. Fullerite microcrystals are clearly seen in the photograph. In this case exofullerized cellulose fibers resulted from introduction of fullerite in the water-soluble state into the initial suspension are seen in the photograph.

At present laboratory 67 in Institute for Problems of Material Science of National Academy of Sciences of Ukraine and the department of ecology and paper in National Technic University of Ukraine "Kiev Polytechnic Institute" perform investigations into physical and chemical properties of cellulose-fullerene composites, features of their synthesis, structure, construction both at micro- and nanolevels.

Conclusions

In our opinion, protection of securities using fullerenes may be protection of the highest level. As fullerenes are new inaccessible materials, nobody owns the method for their detection in paper.

Fullerene introduction into paper is the difficult process that requires special skill and knowledge. Moreover, formation of solid substitution solutions in the C_{60} crystal lattice (with C_{70} and other fullerenes) gives possibility to combine fullerenes in the wide range of concentrations. This allows creation of compositions which decoding is very labor-consuming and requires much time and special equipment. All the mentioned above makes counterfeit of the paper encoded by fullerenes practically impossible. Pink color of paper, caused by fullerene introduced, will allow application of fullerenes for protection of pink dollars.

Our scientific group has a number of patents of Ukraine for chemical and technological methods for fullerene conversion in the water-soluble state and inversely, methods and techniques for introduction of fullerenes and fullerene-containing products into the paper composition.

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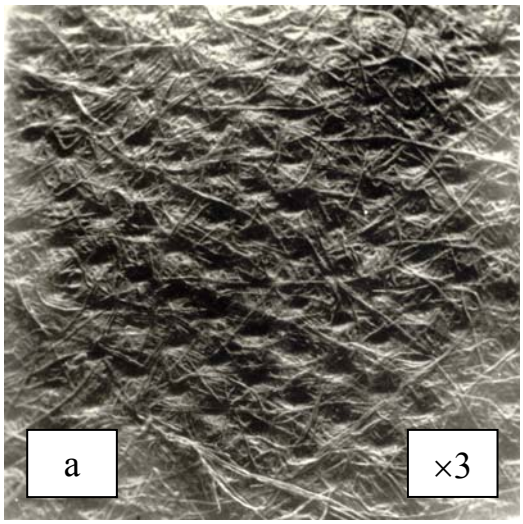
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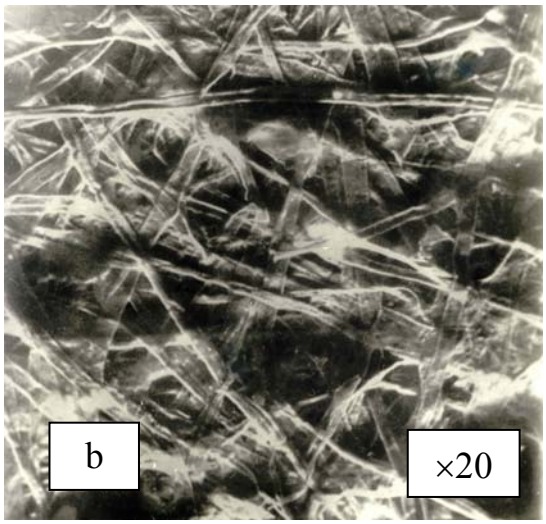
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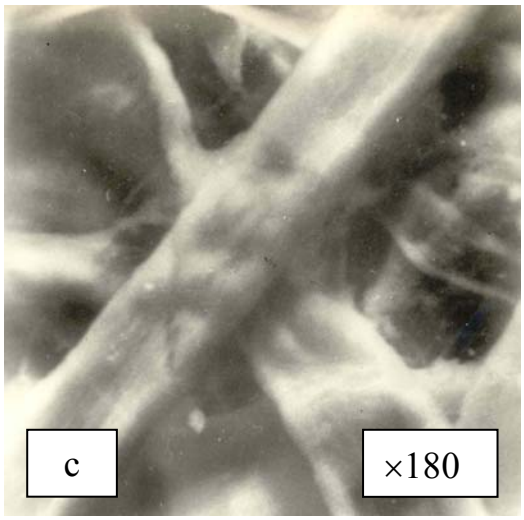
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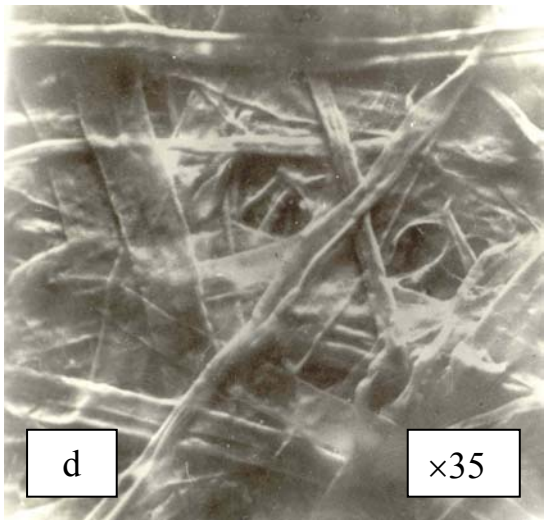
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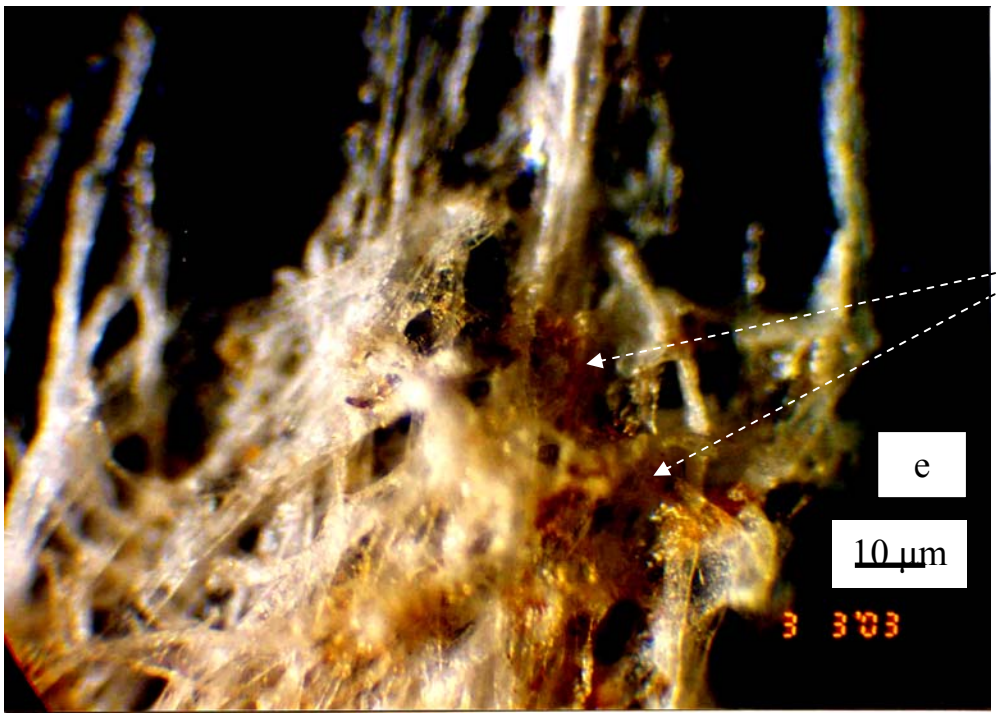
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