JOURNAL OF NANO- AND ELECTRONIC PHYSICS
Vol. **6** No 3, 03008(3pp) (2014)

ЖУРНАЛ НАНО- ТА ЕЛЕКТРОННОЇ ФІЗИКИ
Том **6** № 3, 03008(3cc) (2014)

Obtaining New Dental Materials Reinforced with Carbon Nanotubes

I.V. Zaporotskova, L.S. Elbakyan

Volgograd State University, 100, University Av., 400062 Volgograd, Russia

(Received 19 May 2014; revised manuscript received 01 July 2014; published online 15 July 2014)

The article seeks to explore the change of strength properties of composite polymer material on the basis of fast-hardening dental plastic "Carbogen", when reinforcing its coal-native nanotubes. Were discussed peculiarities of composition of Carboante, ways of creation of polymeric composition deposits by doping their carbon nanotubes, the results of measuring the strength characteristic characteristics obtained new polymer materials. On the basis of the analysis of the practical and the theoretical-sky research, conclusions were drawn on the feasibility of a new filling material with the use of carbon nanotubes with unique strength characteristics and use of their in dentistry.

Keywords: Carbon nanotubes, Carbogen, Polymers, Doped, Strengthening, Hardness.

PACS number: 81.07._b

1. INTRODUCTION

Rapid-hardening plastic is widely used in dentistry clinic for relocation (patch) prostheses, repairing dentures, orthodontic apparatus manufacture (kapp, tyres), temporary prostheses, individual impression spoons. Fast-hardening plastic also holds a firm place among filling materials.

It is known that the life of orthodontic apparatus of fast-hardening plastic is shorter than the duration of active orthodontic treatment [1]. So you must create new dental materials with improved characteristics. Special expectations associated with the use of unique coal-native nanomaterials – carbon nanotubes [2-3]. The use of carbon nanotubes to improve the physical-chemical properties of polymers today is commercial practice and distributed in numerous industries. To accomplish this, you must make a good pairing between the surface of the CNT and the polymer matrix. This ensures the effective transfer of load from polymeric material nanotube and, ultimately, leads to increased durability and improve their operational properties. One of the expected properties of plastics-doped carbon nanotubes, is the increase of their durability while maintaining the required flexibility. Therefore the main target of the study was to determine the feasibility of doping quick plastics used in dentistry, carbon nanomaterial and study some properties of the composites obtained. In the available literature we have not met data on the use of nanoparticles as gain strength rapidly hardening plastics.

In connection with the above, the purpose of this study was the creation of a new doped material (polymer) on the basis of fast-hardening plastic "Carbodent" [4].

2. DESCRIPTION OF OBJECTS AND METHODS OF RESEARCH

In our study as a polymeric matrix was used material "Carbogen"used in dentistry. Carbogen - composite filling material based on the acrylic copolymers [4]. Carbodent is acrylic composition type powder – liquid" with filler, hardened at room temperature. Powder Carboant, in addition to triple methacrylate copolymer, butyl methacrylate and methacrylic acid, contains about 40 % of mineral filler – quartz as well as zinc oxide, and benzoyl peroxide. Fluid carboante – methyl methacrylate containing adduct epoxy resin and methacrylic acid, dimethylacetamide, stabilizer and antistatical.

Preparation of polymer composites can happen on the basis of two principles: the dissolution of the nanotubes in polymer matrix and covalent embedding nanotubes in polymer molecule. Dissolution of nanotubes in polymer matrix can be done in three ways [5]:

1. The dispersion of nanotubes in solvent polymer. After dispersion in colloid the polymer is disolved. The solvent is then argonauts thus, to prevent coagulation nanotubes (for evaporated this by evaporation of a liquid should not appear bubbles). Usually the solvent is evaporated with natural method in operating the ultrasonic bath with warm water under the hood or in a water bath. After distillation, the most part of the solvent remaining mixture can be evacuated to the distillation of remaining solvent. The drawbacks of this method include the incomplete removal of the solvent and the breakdown of the initial structure of the polymer.

2. The dispersion of the nanotubes in the polymer. This method applies only to the polymer with low viscosity or polymer solutions. The dispersion of the nanotubes in polymer is done by ultrasound, after which he hardens.

3. For plastics, coated with a special substance - promoter holds a special way. In this method, the carbon nanotubes dispersed it in the hole, and then the variance is mixed with curable polymer for best uniformity of distribution of carbon nanotubes slightly warmed to a temperature just above the softening temperature. The main problem with this method is fast and homogeneous distribution of hardener in the polymer, which is complicated by the process of curing polymer, the consequence of which is the lower speed of diffusion of a mixture of nanotubes with hardener. This leads to non-uniform distribution of nanotubes in polymer and, therefore, the uneven distribution of the properties of the polymer volume. However, this method is extremely important for additives nanotubes to viscous polymers, when the contact of the polymer with the solvent is undesirable. Covalent embedding nano-

The article was reported at the International Conference «The Advanced Technology, Equipment and Analytical Systems for Materials», Kursk, 13-14 May, 2014

tubes in polymer is a very promising method of hardening of polymers, as part of the polymer molecule is the structure that has a strength of about 45 GPA on a break. We have prepared the polymer samples with different content of carbon nanotubes and without them. These samples were tested on the hardness (Rockwell method). To prove the possibility of the implementation of the proposed mechanism, were made MNDO-settlement process of interaction of the basic polymer components "Carboante" (methylmethacrylate, butyl methacrylate, methacrylic acid) and single-wall carbon nanotubes. In the structure of molecules of the components have been selected as the most active centers that are able to provide stable communication molecules with the surface of the CNT.

3. DESCRIPTION AND ANALYSIS OF THE RESULTS

Analysis of the results obtained in the experimental part, has allowed to conclude that even small doping of carbon nanotubes in the total volume of the polymer matrix "Carbogen" (0,05 %) almost in 2 times increases the strength of the material. This provides significant operational improvement dental plastic without critical deterioration of its color characteristics. Figure 1 shows the graph of the hardness of dental material percentage of carbon nanotubes.

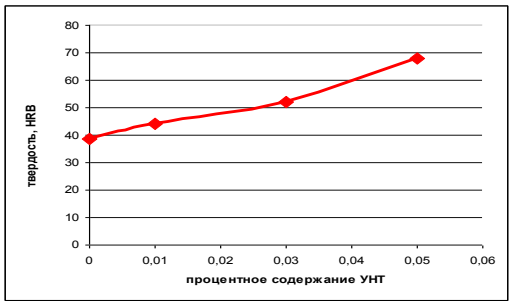

Fig. 1 – The Schedule of dependence of hardness polymer material percentage in it CNT

Improvement of properties of polymer can occur due to interaction "Carboante" with CNTS. As a result of theoretical calculations were built energy curves of interaction. In Fig. 2 as an example presented the curves of interaction nanotubes with methyl methacrylate molecule and methacrylic acid – a component of "Carbodant".

The analysis of curves is found that the adsorption interaction is implemented at certain distances appropriated occasion physical adsorption. The accession process of polymer components for all the adsorption centers happens to overcome the potential barriers. However, their height is small, so the barriers are easy to overcome molecules. Main characteristics of interaction are presented in table 1. Analysis of the results (of energy values adsorption) has allowed to conclude that the interaction is more likely carried out through the active centre of molecules of the components the oxygen atom.

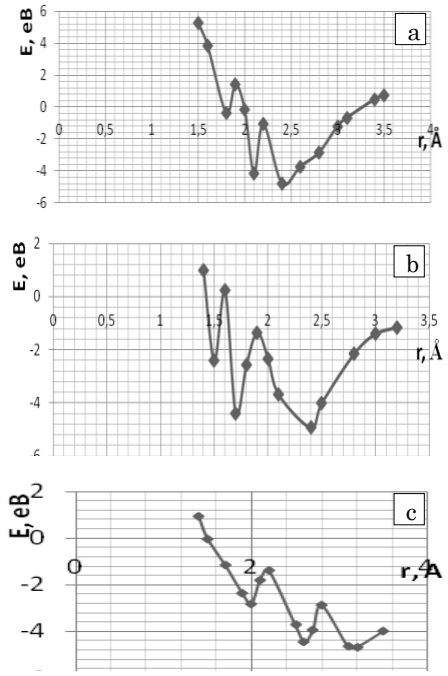

Fig. 2 – Profile of the potential energy of interaction of the CNT in the interaction through the active centre: a) the hydrogen atom molecules $C_4H_6O_2$; b) atom of oxygen molecules $C_4H_6O_2$;) atom of oxygen molecules $C_5H_8O_2$.

Table 1 – Main characteristics of the interaction of carbon nanotubes with molecules

	r, Å	E_{adsorb}, eV	E_{ectiv}, eV
atom of hydrogen molecules $C_4H_6O_2$	2,4	– 4,92813	3,58392
	1,7	– 4,41046	
atom of oxygen molecules $C_4H_6O_2$	2,4	– 4,7943	3,7321
	2,1	– 4,18726	
	1,8	– 0,38897	5,60938
atom of oxygen molecules $C_5H_8O_2$	3,2	– 4,66735	1,78964
	2,4	– 3,84998	
	2,0	– 2,82655	3,05017

4. CONCLUSIONS

Analysis of the results of measurement of hardness allowed to make a conclusion that even minor doped carbon nanotubes in total polymer matrixs of carbodant (0.005 %) provides a significant performance improvement characteristics dental plastic without the critical deterioration of its color characteristics. Composite reinforced carbon nanotubes, polymers of such structure can be recommended for use which can be used effectively not only in the practice of orthodontics, but in subsectimeoriginal practices to create high strength of seals. Higher content of single-wall carbon nanotubes increases the hardness of the composite 15 times compared with neoperabelny material "Carbogen". Such polymer systems are expedient to use for creation of dentures, orthodontic apparatus manufacture, temporary prostheses, individual impression spoons, where strength characteristics of the material is much more important compared with the disadvantages of color characteristics.

REFERENCES

1. A.K. Brel, S. Dmitrienko, O.O. Kotlyarevsky, *Polymer Materials in Clinical Dentistry* (Volgograd: LLC "Form": 2006).
2. M.S. Dresselhaus, G. Dresselhaus, P. Avouris, *Carbon Nanotubes: Synthesis, Structure, Properties, and Application* (Springer: Verlag: 2000).
3. P.N. Dyachkov, *Electronic Properties and Application of Nanotubes* (Moscow: BINOM: 2010).
4. V.I. Lukyanenko, K.A. Makarov, M.S. Steingart, P.S. Alekseeva, *Composite Filling Materials* (Medicine: 1988).
5. I.V. Zaporotskova, *Carbon and Non-carbon Composite Nanomaterials and Structures on Their Basis: Structure and Electronic Properties* (Volgograd: in the Volsu: 2009).