

SOME PROPERTIES AND APPLICATION OF NANOSIZE AMORPHOUS METALS AND THEIR OXIDES IN PREPARATION OF NEW POLYMERIC NANOCOMPOSITES.

R.Malkhasyan¹, G.Kazanchyan², S. Grigoryan¹ and B. Daturyan²

1. Scientific Production Enterprise “Nanoamorph Technology” CJSC Tevosyan 3/1, Yerevan 0076, Republic of Armenia, E - mail: rmalkhas@netsys.am.

2. “Arniikp” CJSC Acharyan 40, Yerevan 0040, Republic of Armenia.

The principle of obtaining amorphous nanosize metals (not alloys) is based on the use of nonequilibrium quantum-chemical technology [1-2], in which practically at room temperature (or ambient temperature) endothermic reduction processes of oxides (or other compounds) of various metals take place by means of vibrationally highly excited hydrogen molecules.

At present, “Nanoamorph Technology” company produces amorphous metals W_2 , W_3 , etc. as well as their derivatives, for example amorphous nanosize W_2 and W_3 , W_2 and W_3 type oxides sized less than 5 nm. We will note that these dioxides are good p and n type semiconductors (maintaining their semi-conductor properties up to 500-550 °C, for example, in case of W_2). The obtained in the company nanoamorphous metals and their derivatives do not have even short-range order and are referred to as true or truly amorphous materials [3-4].

The main property of these nanosize truly amorphous materials are their very high energy content both for all nanosize crystalline materials with a Grain Boundary Energies and all amorphous materials, which also additionally isolate high quantity energy when transforming into crystalline state. As a result, they reveal high chemical and catalytic activity as well as sensor properties [5].

Now, the most important spheres of applications of nanoamorphous materials are:

1. Masksless nanolithography when creating nanoelements for nanoelectronics. Here, new resources of additional energy release when transforming amorphous metals into crystalline state are used upon their insignificant heating by a simple PC-controlled increase of current through probe in a device similar to AFM microscope. There is also a possibility of creating new hybrid amorphous-crystalline structures.
2. Creation of new nanocomposites both in various polymeric special-purpose matrixes

and in metal matrixes, for example, of similar metal, to form super-dense and super-hard structures. Earlier our nanosize amorphous W_2 -doped molybdenum was used as an additive to polymeric matrices of polyphenylene sulfide and formaldehyde-dioxalane copolymer to obtain wear resistive nanocomposites. Addition of nanosize metal to the copolymer carried out at the Yerevan Engineering University has shown increase of wear resistance by a factor of 3-4, and the same addition to the 7 % polyphenylene sulfide carried out by Prof Sh. Bahadur at the Iowa State University of Science and Technology has resulted in 12-fold increase of wear resistance of the nanocomposite, making this initially hard polymer similar to metals. The work on increasing nanocomposite wear resistance is continued now by modification of polystyrol matrix using nanoamorphous additives.

Earlier, at Yerevan «ARMNIIKP» by modification of polychloroprene rubber “Nairit” produced in Armenia, with addition of natural amorphous silicate filling agents, it was possible to increase oil resistance of the obtained rubber composite almost two times, having provided considerable cost reduction [6]. It is clear that the use of nanoamorphous additives to polymeric matrix of synthetic polychloroprene rubber “Nairit” is of intense interest in obtaining new composite industrial materials for cable industry.

With that end in view, this work studies modification of synthetic polychloroprene rubber (PPR) “Nairit” by addition of nanosize amorphous metals W_2 and W_3 . As the amorphous nanosize metals oxidate in air due to their activity, to introduce to the polymeric matrix they were introduced from vacuum in a high-quality vacuum oil. Then they were introduced to polychloroprene rubber using mixing rollers. Then from these nanocomposites vulcanization of samples under high pressures and temperature was carried out

and 2 mm thick plates were obtained. Standard samples were cut out from the plates to determine percentage elongation and bursting strength in MPa. Similar comparative measurements were carried out for pure polychloroprene rubber (without additives). The obtained results at vulcanization temperature 140° are presented in Table.

	PPR without additives	PPR+0.5% of	PPR+5% of	PPR+5% of W
%	660	900	486	683
M	1.16	7.0	2.42	6.0

It is seen from the Table that bursting strength of nanocomposites with additives essentially increases.

It is interesting that reduction of the amount of additive by an order of magnitude has led to increase of maximum bursting strength by a factor of 3. It is especially important, as allows sufficient decrease of expenses per unit weight of synthesized nanocomposite. Similar dependences are investigated also at vulcanization temperatures 100° and 180°. Researches have shown that bursting strength of polychloroprene rubber without additives monotonously grows with temperature, and that of metal-doped polychloroprene rubber reveals maximum at 140°. Polychloroprene rubbers with 0.5 % and 5% of amorphous nanosize ₂ behave

identically. It is possible to assume that overdose of the nanoamorphous additives takes place.

The obtained results undoubtedly testify to perspective of this direction, and further activity will allow specification and optimization of the production of nanocomposite with amorphous fillers.

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