THE REASONS FOR DIVERGENCE BETWEEN THEORETICAL AND EXPERIMENTAL VALUES OF MODULES OF ELASTICITY OF COMPOSITIONS ON THE BASIS OF POLYMERS AND PIEZOELECTRIC CERAMICS

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ABSTRACT

The reasons for divergence between theoretical and experimental values of modules of elasticity (Young's) of composition on the basis of polymers (polyethylene and polyvinilidenftorid) and piezoelectric ceramics (PCR3M and PCR8) have been considered.

Keywords: divergence, piezoelectric, ceramics, polymers, elasticity.

I. INTRODUCTION

While using the devices of different sensors and converters with composition elements on basis of polymers and piezoelectric ceramics, besides electrophysicals and strength properties their elasticity properties are also important [1-4]. Therefore, to study the elasticity properties of Young's modules in particular, compositions on the basis of polymers and piezoelectric ceramics in of scientific-practical interest.

At presents there is no satisfactory formula for calculate the elasticity properties of compositions on the basis of polymers and piezoelectric ceramics.

II. MAIN PART

First of all, it is connected with the fact that while deriving calculation formulas, some assumptions are made and several process taking place in the real compositions, connected with their degree of disorder are not taken into account.

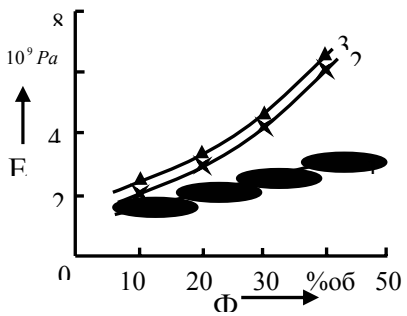

Fig.1 the dependence module Young's from by volume content of piezoceramics for compositions PVDF+PCR3M (3) and PVDF+PCR8 (2)
1-therotically,
2 and 3-exsperimentally

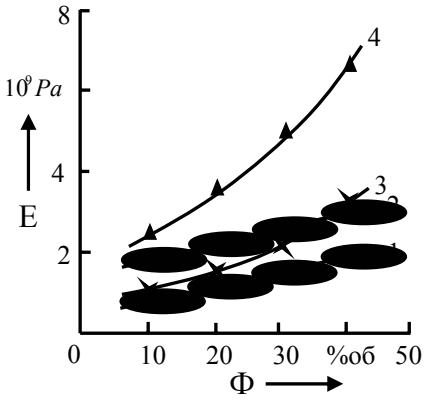

Fig.2 the dependence modules Young's from by volume content of piezoceramics for compositions PVDF+PCR3M (2,4) and PE+ПКР3М (1,3)
1,2- theoretically,
3 and 4- experimentally

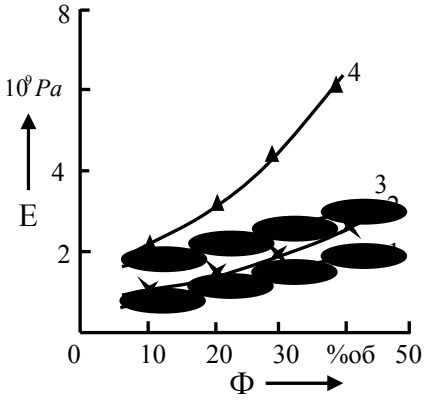

Fig.3 the dependence module Young's From by volume content of piezoceramics for compositions PVDF+PCR8 (2,4) and PE+ПКР8(1,3)
1,2- theoretically,
3 and 4- experimentally

Young's modules **E** for two phase compositions with spherical disperse expressed by the formula:

$$E = \frac{3(1-\Phi)E_1 + (2+3\Phi)E_2}{(3+2\Phi)E_1 + 2(1-\Phi)E_2} E_1 \quad (1)$$

where $\mathbf{E_1}$ and $\mathbf{E_2}$ - elasticity constants of the polymer matrix and piezoparticles accordingly, **Φ**- content of piezoceramics by volume. It is known that the piezoparticles $\mathbf{E_2}$ of Young's modules are significantly more than the polymers $\mathbf{E_1}$ of Young's module. $\mathbf{E_2 >> E_1}$. Then the formula (1) can be written in the form of:

$$E = \frac{2+3\Phi}{2(1-\Phi)} E_1 \quad (2)$$

It is clear, that elasticity constant **of** the compositions **E** dose not depend on the elasticity constant of the piezoparticles $\mathbf{E_2}$, but it is defines by the elasticity constant of the polymer $\mathbf{E_1}$ and content of piezoparticles **Φ** by volume. For made compositions have been selected polymer matrix, polyethylene and polyviniliydenflorid and as piezoelectric ceramics PCR3M and PCR8. The compositions have been made by means hot pressing the mechanical mixture of polymers powder and piezoelectric ceramics of PCR3M, PCR8 types separately at a melting temperature of polymer matrix under the pressure of 15 Mpa during 10 min, followed by cooling. A value of the modules Young's of compositions is experimentally determined from $\sigma = f(\varepsilon)$ graphics and calculated by the formula $\sigma = \varepsilon E$.

Values of Young's modules E depending on the content by volume Φ, calculated by according to the formula (2) for the compositions PVDF+PCR3M, PVDF+PCR8, PE+PCR3M and PE+PCR8 are given in the graphics 1,2 and 3. it in these graphics for compositions the experimental dependence of **E** from **Φ** in given . As it is shown in the graphics, the values of Young's modules **E** for compositions PVDF+PCR3M and PVDF+PCR8 other things being equal, with the same content by volume Φ are more than the values E for composites PE+PCR3M and PE+PCR8 accordingly. From the graphics 1,2 and 3 it is also clear that the value for the compositions PVDF+PCR3M and PE+PCR3M are more than values of **E** for compositions PVDF+PCR8 and PE+PCR8 accordingly. It is explained the fact that, firstly PVDF is polar but PE is unpolar polymer. Secondly, piezoelectric ceramics PCR3M is of rombohedrial but ceramics PCR8 is of tetragonal structure. Besides it, piezoelectric ceramics PCR3M in comparison with piezoceramics PCR8 possesses more reorientation polarization and electronegative increasing adhesion of polymer matrix piezoelectric ceramics. On the other hand from graphics 1, and 3 it is clear that calculated (theoretical) values of Young's modulus for compositions **E** in all values of content of piezoceramics by volume Φ are significantly less that the value **E** depend experimentally, the difference between experimental and calculated vales **E** increase as the content of piezobiner increases by volume.

III. CONCLUSION

The difference observed between experimental and theoretical values of modulus of elasticity **E** of compositions is connected, to our mind with not taking into consideration the interphase interactions thickness of the boundary layer in compositions systems of polymer piezoceramics.

REFERENCES

1. .S.A.Abasov, M.A.Ramazanov Fizika 1999,v.5 pp.11-13 (In Russia)
2. S.A.Abasov, M.A.Ramazanov, Z.E.Mustafaev, Fizika, 2001,v.7, pp.24-26.(In Russia)
3. S.A.Abasov, M.A.Ramazanov, H.S.Ibragimova ,Z.E.Mustafaev Physics and chemistry of processing of materials. 2003, 5, pp.87-88. (In Russia)
4. H.S.Ibragimova, M.A.Ramazanov, S.A.Abasov Problems of power.2004, 2 pp.26-29. (In Russia)