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STRENGTH STRUCTURE OF INTERRELATIONSHIPS IN AMORPHOUS CRYSTALLINE POLYMERS

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Abstract- The results of the study of electrical and mechanical strength of amorphous crystalline polymer systems with linear structure and their dependence on macromolecular structures are described. It is well-known that linear structure polymer systems are characterized by inter-atomic distances with sizes 3-5 Å and at the same time with a large period of reproduction caused by macromolecules with sizes 50-1000 Å. Depending on the thermodynamic parameters of the technological process of the material preparation and other time-temperature regimes, samples can be obtained with different structures. Given that polymeric materials are widely used in various industries, it is confirmed that the aforementioned areas of research are among the topical issues of the day.

Keywords: Polymer, Electrical, Mechanical Properties, Structure, Fibrilla, Spherulite, Period, Technology, Electrical Gas Discharge.

I. INTRODUCTION

Electrical and mechanical sealing of polyethylene, polypropylene, and polyvinylidene fluoride materials with spherulite structure prepared by hot pressing at different pressures (P_1 = 50, P_2 = 100 and P_3 = 150 atm) and processed at different crystallization (T_{cr}) temperatures were initially investigated in the research work.

Polymer systems consisting of macromolecules and characterized by a specific, chain-chemical structure are subdivided into polycrystalline classifications that are physically separated by crystalline and amorphous structures. It should be noted that irreplaceable use in other important areas of the economy, life, medicine, technical and technological processes, areas requiring high electrical and mechanical strength, production of extreme equipment, and replacement of biological objects. Some other cases in electro technical materials of both polymeric materials in electrotechnics implied the need for intensive research of the physical, electro physical, mechanical, chemical, biological and other properties of these materials.

To date, numerous studies have been carried out on the study of polymeric materials, the aforementioned properties, and relevant findings have been obtained in the literature [1-10].

Due to the wide variety of polymeric materials, their differences in structure, properties, methods of synthesis and production conditions, separate theoretical considerations have been made due to the impossibility of single theoretical bases covering the structure, properties and "structural-property" relationships of polymer materials. The paper presents the results of the experimental study of the dependence of the electrical and mechanical properties of polyethylene linear polymer systems with amorphous crystalline structures on the parameters of the material processing.

It should be noted that in the literature, polymer materials with thin (150-200 micros) layers were used in the study of polymer materials. The limitations of the studies on the samples of the polymer materials with a block (1-2 mm) thickness and the discrepancy of the results have led to controversies and differences in the literature. The important scientific and practical importance of studying electrical and mechanical properties in amorphous - crystalline polymeric systems stimulates further research in this area. Thus, the results of research in this area are used not only to study the properties of the material, but also as a method for studying the structure and "structural-property" relationships of the polymer, which provides the scientific significance of the results obtained in the studies.

It is known that the properties of solid-state material, including polymers, depend on its chemical composition and physical structure. Given that the structure of linear polymer systems is sensitive to external influences; it is possible to control the properties of the polymer material by changing the structure of the material processing technology by changing the structure of the material.

Linear polymer systems are composed of amorphous and crystalline parts, because amorphous parts are characterized by chaotic - irregular arrangement of the beginning and end parts of macromolecules, and crystalline parts - with multiple defects and regular formation of macromolecules.

It should be noted considering that the material density in crystalline parts is greater than the amorphous and distinguish between regular and irregular structure different mechanisms of elastic and non-elastic deformation processes in polymeric materials, depending on the processing technology, can be observed in different mechanisms of transition from isotropic to anisotropic. Given the melting temperatures of the polymers, the processing technology can ensure that the polymeric materials have different structures through varying the processing technology by changing the melting temperature, the pressing pressure, the crystallization temperature, the deformation temperature, the deformation rate and other parameters.

II. RESULTS AND DISCUSSION

Table 1 presents the experimental results from the study of electrical and mechanical strength of polyethylene material with a spherulite structure of 1 mm thickness.

Table 2 presents the experimental results reflecting the electrical and mechanical strength of polyethylene material with a fibrillar structure.

Table 3 presents the experimental results describing the electrical and mechanical strength of polypropylene with spherulite structure.

Table 4 presents the results of the study of the electrical and mechanical strength of polyvinylidene fluoride with spherulite structure.

Table 1. Electrical and mechanical strength of polyethylene with spherulite structure made by hot (200 °C) pressing method

Electrical Strength				
	T_{cr}, °C	P_1=50 atm	P_2=100 atm	P_3=150 atm
		kV/mm		
1	20	34.3	37.2	36.5
2	60	35.4	38.6	37.1
3	95	34.5	36.2	35.3
Mechanical Strength				
	T_{cr}, °C	P_1=50 atm	P_2=100 atm	P_3=150 atm
		kgs/cm^2		
1	20	95	110	105
2	60	98	120	114
3	95	92	103	100

Table 2. Electrical and mechanical strength of polyethylene material with fibrillar structure, in the direction of an axis l = 300% tension deformation

Electrical Strength					
	T_{cr}, °C	l, %	P_1=50 atm	P_2=100 atm	P_3=150 atm
			kV/mm		
1	20	100	38.2	41.4	40.3
2	60	200	40.5	43.7	42.4
3	95	300	43.6	44.1	45.6
Mechanical Strength					
	T_{cr}, °C	l, %	P_1=50 atm	P_2=100 atm	P_3=150 atm
			kgs/cm^2		
1	20	100	110	125	123
2	60	200	127	135	132
3	95	300	140	145	149

Table 3. Electrical and mechanical strength of polypropylene with spherulite structure

Electrical Strength				
	T_{cr}, °C	P_1=50 atm	P_2=100 atm	P_3=150 atm
		kV/mm		
1	50	40.5	46.2	42.5
2	100	44.1	49.3	47.6
3	150	43.2	45.7	44.3
Mechanical Strength				
	T_{cr}, °C	P_1=50 atm	P_2=100 atm	P_3=150 atm
		kgs/cm^2		
1	50	130	148	142
2	100	180	210	200
3	150	172	184	179

Table 4. Electrical and mechanical strength of polyvinyliden-fluoride with spherulite structure

Electrical Strength				
	T_{cr}, °C	P_1=50 atm	P_2=100 atm	P_3=150 atm
		kV/mm		
1	50	30.5	34.6	32.4
2	100	33.1	35.2	34.3
3	150	32.6	33.8	33.4
Mechanical Strength				
	T_{cr}, °C	P_1=50 atm	P_2=100 atm	P_3=150 atm
		kgs/cm^2		
1	50	340	352	343
2	100	348	356	350
3	150	344	349	346

The results of Tables 1, 3 and 4 show that electrical and mechanical strength of polyethylene material with spherulite structure at P = 100 atm. of hot pressing and at T_{cr} = 60 °C of the crystallization temperature, and at T_{cr} = 100 °C, P = 100 atm. of hot pressing the electrical and mechanical strength of polypropylene and polyvinylidene fluoride materials is higher than in other cases. The aforementioned temperature-pressure parameters can be considered optimal parameters in terms of electrical and mechanical strength of polyethylene PP and PVDF materials with spherulite structure.

At low prices for hot presses, electrical and mechanical strengths are characterized by low values due to the large number of defects in the material, the presence of gas bundles, the low crystallization rate, and the high crystallization temperature due to deformation of material.

It should be noted that the values obtained from the experimental study of the electrical and mechanical strength of the polyethylene material with a fibrillar structure traction deformation in an axis direction l = 300% are different. Thus, at higher prices for crystallization temperatures, hot pressures, and deformation rates, electrical and mechanical strengths show higher values.

III. CONCLUSION

The results of the research show that the electrical and mechanical strength of linear polymer systems is due to the large, repetitive, structural elements of the macromolecules that make up the material. The stated properties of materials depend on the parameters of their manufacture and processing technology. Thus, by changing the processing technology parameters, the properties of the polymer materials can be adjusted as required by their application areas.

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BIOGRAPHIES

Arif Mamed Hashimov was born in Shahbuz, Nakhchivan, Azerbaijan on September 28, 1949. He is a Professor of Power Engineering (1993); Chief Editor of Scientific Journal of "Power Engineering Problems" from 2000; Director of Institute of Physics of Azerbaijan National Academy of Sciences (Baku, Azerbaijan) from 2002 up to 2009; and Academician and the First Vice-President of Azerbaijan National Academy of Sciences from 2007 up to 2013. He is laureate of Azerbaijan State Prize (1978); Honored Scientist of Azerbaijan (2005); Cochairman of International Conferences on "Technical and Physical Problems of Power Engineering" (ICTPE) and Editor in Chief of International Journal on "Technical and Physical Problems of Engineering" (IJTPE). Now he is a High Consultant in "Azerenerji" JSC, Baku, Azerbaijan. His research areas are theory of non-linear electrical Networks with distributed parameters, neutral earthing and ferroresonant processes, alternative energy sources, high voltage physics and techniques, electrical physics. His publications are 350 articles and patents and 5 monographs.

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