THE INFLUENCE OF TEMPERATURE –TIME CRYSTALLIZATION MODE ON THE MECHANICAL STRENGTH AND ON THE STRUCTURE OF POLYMERIC MAGNETIC NANO-COMPOSITES ON PVDF+Fe_3O_4 BASIS

P.B. AGAKISHIYEVA, S.A. ABBASOV, R.A. ALI-ZADE
Institute of Physics of NASA,
AZ-1143 Baku, Azerbaijan, H. Javid ave. , 33

M.A. RAMAZANOV
Baku State University
Baku, Az 1145, Z.Khalilov str.23

The investigation results of the influence of temperature-time crystallization mode on the microstructure and on the strength properties of compositions on PVDF+Fe_3O_4 base are described in the given work. It is shown, that increase of mechanical strength of nano-composition samples, obtained in the modes of slow cooling is connected with increase of interphase interaction of composition components, and increase of nano-particle sizes is connected with increase of coagulation probability of Fe_3O_4 particles.

Last time the magnetic nano-structures are successfully used for the high-density magnetic record of information, pigmentation, in the micro-wave coverings, at magnetic cooling and other technique spheres.

The nano-composite properties are defined by the chemical nature of polymeric matrix, structure of interfaces, the part of which is too large in nano-composites, and also by the interaction between nano-particles and polymer matrix. The temperature-time mode of polymer crystallization changes the physical structure of the polymeric matrix and interphase interactions between composite components that leads to the change of the composition strength properties [1-5].

The investigation results of the influence of temperature-time crystallization mode on the microstructure and strength properties of compositions on PVDF+Fe_3O_4 base are described in the given work. The magnetic polymeric nano-composites are obtained by the following way. The Fe_3O_4 nano-particles are added to the PVDF solution in dimetilformamid. The nano-particle size is 4-10nm. The mixture is mixed at the temperature 343K up to the emulsion formation, the water solution is added and Fe_3O_4, consisting PVDF, is steamed and further is dried in vacuum safe. The nano-composite samples are obtained from the compound by the method of hot pressing at PVDF melting point under the pressure 15MPa during 10 minutes with further cooling up to room temperature at various velocities.

The microstructures of PVDF+Fe_3O_4 compositions are investigated on the scanning atomic force microscope (AFM).

The mechanical strength properties of nano-composition samples are defined at temperature 293K. The mechanical strength of nano-composition samples, obtained in the modes of quick cooling (QC) β=2000grad/min and slow cooling (SC) β=4grad/min are studied. It is experimentally established, (fig.1) that mechanical strength of PVDF+Fe_3O_4 nano-composition, obtained in the mode β=4grad/min bigger, than nano-composition samples have obtained in the modes β=2000grad/min. It is also shown, that the small increase of mechanical strength of PVDF+Fe_3O_4 nano-composition is observed in the dependence on the volume content of Fe_3O_4 nano-particles up to 2%v.con., after that the concentration increase takes place up to 20%v.con.

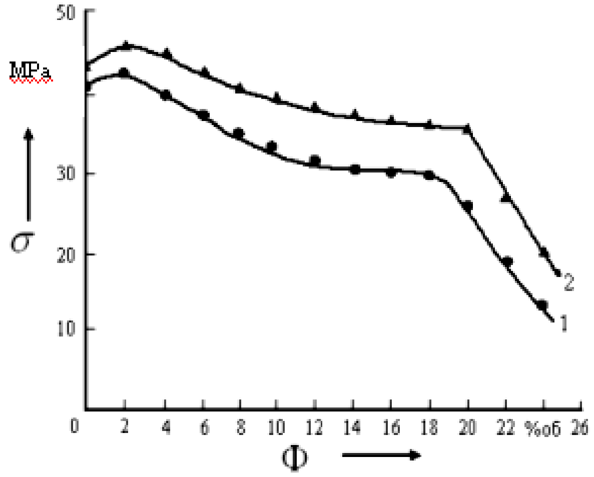


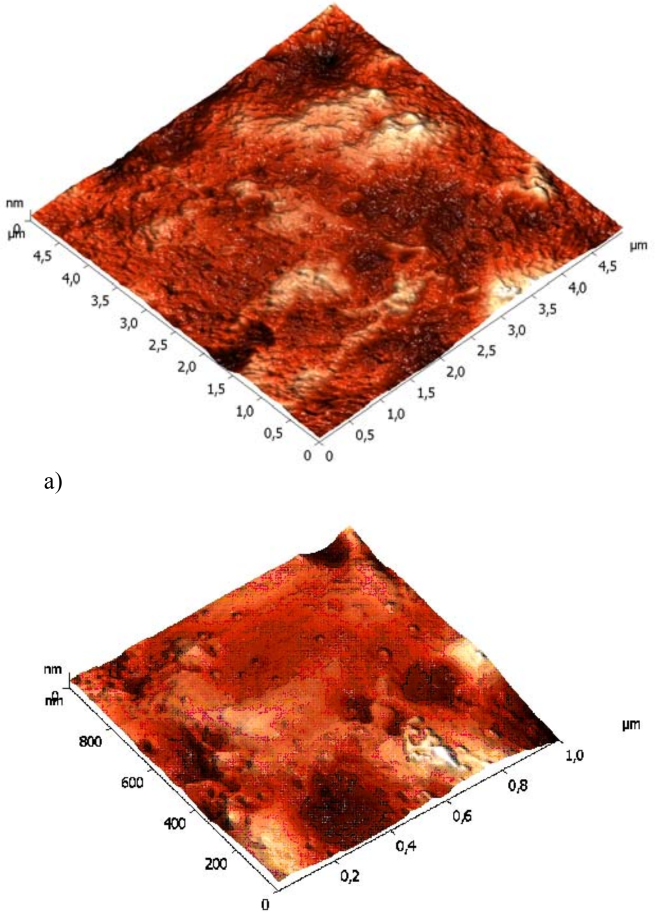
Fig.1. The dependence of mechanical strength on the filler volume content, obtained in the different cooling modes. 1. β=2000grad/min (QC) 2. β=4grad/min (SQ)

Further increase of nano-particle concentration leads to the strong decrease of mechanical strength of this nano-composition. From the fig.1 it is seen, that change regularity of nano-composition mechanical strength on the volume content of Fe_3O_4 is saved for the samples, obtained in the modes β=4grad/min and β=2000grad/min.

By our opinion the small increase of nano-composition mechanical strength till 2%v.con. of Fe_3O_4 concentration is connected by the structuring of polymeric matrix. The nano-particles play the role of crystallization center in them, if additions of Fe_3O_4 are 2%v.con.

Further decrease of mechanical strength is connected with the decrease of the part of polymeric matrix with the concentration increase of Fe_3O_4 nano-particle. The strong decrease of nano-composition mechanical strength is higher 20%v.con. that is connected with destruction of polymeric matrix.

AFM 3D image of region topography of nano-composition surface PVDF+Fe_3O_4, obtained in the modes β=4grad/min is given on the fig.2. It is seen, that at slowcooled samples the nano-composition relief becomes more ordered, than at quick-cooled ones.



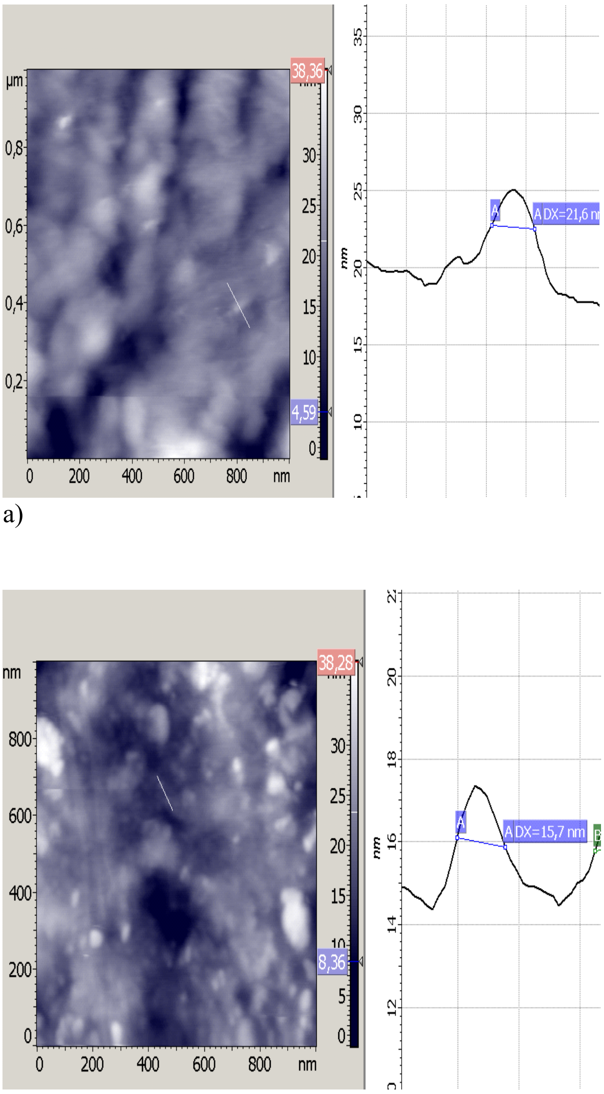
a)

b)

Fig.2. AFM 3D topography image of nano-composition surface region PVDF+Fe_3O_4 a) β=4grad/min. b) β=2000grad/min.

It is known, that crystallinity degree of composite materials much increases at slow cooling of polymers and composites on their base in the comparison with quick-cooled one. The decrease of crystallinity degree in the samples, obtained in the mode of quick cooling, probably can be connected with small crystal structure. By our opinion, the increase of nano-composition mechanical strength of PVDF+Fe_3O_4 samples, obtained in the modes of slow cooling is connected by the formation of more ordered structure of polymeric matrix and increase of interphase interaction of composition components.

The nano-particle sizes, the distribution topography of Fe_3O_4 nano-particle in polymeric matrix for the samples, obtained in the modes β=4grad/min and β=2000grad/min are given on the fig.3. AFM investigation of these samples shows, that sizes of Fe_3O_4 nano-particle change with crystallization temperature-time mode, i.e. at β=4grad/min is 21nm, and in the cooling modes β=2000grad/min is 15 nm (fig.3).



a)

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Fig.3. AFM image of nano-composition surface PVDF+Fe_3O_4 and nano-particle sizes of Fe_3O_4
a) β=4grad/min b) β=2000grad/min.

By our opinion the increase of mechanical strength of nano-composition samples, obtained in the modes of slow cooling is connected with increase of interphase interaction of composition components, and increase of nano-particle sizes is connected with increase of coagulation probability of Fe_3O_4 particle.

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M.Ə. Ramazanov, P.B. Ağakişiyeva, S.A. Abasov, R.A. Əlizadə

KRİSTALLAŞMANIN TEMPERATUR - ZAMAN REJİMİNİN PVDF+Fe_3O_4 ƏSASINDA POLİMER MAQNİT NANOKOMPOZİTLƏRİNİN MEXANİKİ MÖHKƏMLİYİNƏ VƏ QURULUŞUNA TƏSİRİ

Bu işdə kristallaşmanın temperatur - zaman rejiminin PVDF+ Fe_3O_4 əsasında polimer maqnit nanokompozitlərinin mexaniki möhkəmliyinə və quruluşuna təsirinin tədqiqinin nəticələri şərh olunmuşdur. Göstərilmişdir ki, yavaş soyuma rejimində alınmış nanokompozit nümunələrinin mexaniki möhkəmliyinin artması kompozitin komponentləri arasında fazalararası qarşılıqlı təsirin artması ilə əlaqədardır, nanohissəciklərin ölçülərinin artması isə Fe_3O_4 hissəciklərinin koaqulyasiya ehtimalının yüksəlməsi ilə əlaqədardır.

М.А. Рамазанов, П.Б. Агакишиева, С.А. Абасов, Р.А. Али-Заде

ВЛИЯНИЕ ТЕМПЕРАТУРНО-ВРЕМЕННОГО РЕЖИМА КРИСТАЛЛИЗАЦИИ НА МЕХАНИЧЕСКУЮ ПРОЧНОСТЬ И НА СТРУКТУРУ ПОЛИМЕРНЫХ МАГНИТНЫХ НАНОКОМПОЗИТОВ НА ОСНОВЕ ПВДФ+Fe_3O_4

В данной работе излагаются результаты исследования влияния температурного временного режима кристаллизации на микроструктуру и на прочностные свойства композиций на основе ПВДФ+Fe_3O_4. Показано, что увеличение механической прочности образцов нанокомпозиций, полученных в режимах медленного охлаждения, связано с увеличением межфазного взаимодействия компонентов композиций, а увеличение размеров наночастиц связано с повышением вероятности коагуляции частиц Fe_3O_4.

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