Extended Abstract

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Nano fibrillar polymer–polymer and single polymer composites via the "converting instead of adding" concept – Examples of true polymer Nano composite

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Abstract

The review deals with the reasons for the drastic difference between the theoretically derived expectations regarding the mechanical properties of polymer Nano composites and the experimentally obtained results. It is assumed that the most probable reason is the fact that we hardly deal with true Nano composites because in the composites prepared via blending of polymer matrix with the reinforcing Nano-size material the reinforcing elements are not the single Nano particles but their aggregates with sizes in the micrometer range. This situation is due to the fact that currently there are not effective techniques for proper dispersion of Nanomaterial into polymer matrix. The solution suggested is in avoiding the dispersion step in the composite preparation as the "concept of converting instead of adding" does. Two examples of true polymer Nano composites – the Nano fibrillar polymer–polymer and the Nano fibrillar single polymer composites – are described.

Keywords

Polymer Nano composites, Dispersion problem, Mechanical properties, Nano fibrillar polymer–polymer composites, Nano fibrillar single polymer composite

INTRODUCTION

Polymer science, regarding its subject of study, belongs to the oldest fields of science (existing since the times when living cells appeared), while as separate, well defined science it was formulated less than 100 years ago – between 1920 and 1930 – thanks to the pioneering works of the German chemist H. Staudinger. Another peculiarity of polymer science is that polymer materials have always been used by the human beings without having any idea what differs these materials from the others.

Nowadays, when to the natural polymer materials are added numerous synthetic ones with unknown in former time combination of properties, we can hardly imagine our life without these materials. What is more, their number and variety increases continuously because of the large opportunities offered by the new synthetic paths and the property of macromolecules – their chain character. This makes possible the preparation of completely new materials with desired properties or to drastically improve a property in a selected direction of already known material. In parallel to the many advantages of synthetic polymer materials, making them that important and attractive, they have also serious disadvantages as, for example, their adverse environmental impact.

Polymer Nano composites – preparation, mechanical performance, problems

About three decades ago started the preparation of Nanomaterial. According to the recent definition of the European Commission [20] 50% or more of the particles of these materials in their number size distribution is in the size range 1–100 nm in at least one dimension.

All Nano-sized materials, regardless of their chemical composition and method of manufacturing, have a common characteristic feature – the extremely high ratio of surface area to volume. For example, 1 kg of particles of 1 mm^3 has the same surface area as 1 mg of particles of 1 nm^3. The natural tendency to reduce this free surface is the driving force for agglomeration of Nano particles in larger formations.

Solution of the dispersion problem

Do dispersion-free methods for preparation of polymer Nano composites exist? As a matter of fact, there are currently at least two techniques allowing avoiding the dispersion problem in preparation of polymer Nano composites. Both of them result in true Nano composites, i.e. when the Nano-size reinforcing component reaches dispersion to single Nano particles.

Conclusion

Concluding it should be mentioned that nowadays there are enough indications that the concept of polymer Nano composites did not justify the expectations – a drastic difference between the theoretically derived and the experimentally obtained results regarding the mechanical properties of these materials is observed. Among the many reasons for this unexpected situation the most important seems to be the poor dispersion, with other words, we hardly deal with true Nano composites because in the composites prepared via blending of polymer matrix with the reinforcing Nano-size material the reinforcing elements are not the single Nano particles but their aggregates with sizes in the micrometer range. This situation is since currently there are not reliable techniques for proper dispersion of Nanomaterial aggregates into the polymer matrix, and so long such techniques are missing we must avoid the dispersion step in the preparation of true polymer Nano composites as the "concept of converting instead of adding" does. The essence of this concept is in not taking the matrix and reinforcement in their final form but creating one of them during composite processing. In this way, avoiding the dispersion step and achieving a perfect distribution of the Nano-size reinforcement one obtains polymer Nano composites with excellent mechanical performance – up to 300–400% improvement in tensile strength and modulus, i.e. up to 10 times higher than polymer Nano composites prepared via blending of matrix and reinforcement.

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