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The use of nanomaterials with thermoplastic matrices to produce the anti hail systems

Tomasz M. Majka[1],*, Marcin Majka[2]

[1]Faculty of Chemical Engineering and Technology; Department of Chemistry and Technology of Polymers; Cracow University of Technology
[2]Faculty of Physics, Mathematics and Computer Science; Cracow University of Technology

E-Mails: tomasz.m.majka@gmail.com; 1392359@gmail.com;

* Author to whom correspondence should be addressed; Tel.: +48-500-567-355;

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Abstract: New nanomaterials was developed in the field polymer-matrix nanocomposites. Because of incorporated nanoparticles these materials exhibit better phisico-chemical and mechanical properties compare to the appropriate pure polymer matrix. For this reason, these materials can be used for the production of components of anti hail system e.g. for the production of large tubes. Nowadays, hail is the most common problem for growers. Current anti hail systems are rapidly destroyed corrosion and mechanical. Therefore, a new idea is to use nano-engineering to replace some elements of quite popular in Europe the anti hail systems.

Keywords: anti hail systems; polymer nanocomposites;

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1. Introduction

In recent years polymer/layered silicate (PLS) nanocomposites have attracted great interest, both in industry and in academia, because they often exhibit remarkable improvement in materials properties when compared with virgin polymer or conventional microand macro-composites. These improvements can include high moduli [1–3], increased strength and heat resistance [4], decreased gas permeability [5–7] and flammability [3–7], and increased biodegradability of biodegradable polymers [8]. On the other hand, there has been considerable interest in theory and simulations addressing the preparation and properties of these materials [7–9], and they are also considered to be unique model systems to study the structure and dynamics of polymers in confined environments [3–7]. Although the intercalation chemistry of polymers when mixed with appropriately modified layered silicate and synthetic layered silicates has long been known [10,11], the field of PLS nanocomposites has gained momentum recently. Two major findings have stimulated the revival of interest in these materials: first, the report from the Toyota research group of a Nylon-6 (N-6)/montmorillonite (MMT) nanocomposite [1], for which very small amounts of layered silicate loadings resulted in pronounced improvements of thermal and mechanical properties; and second, the observation by Vaia et al. [12] that it is possible to melt-mix polymers with layered silicates, without the use of organic solvents. Today, efforts are being conducted globally, using almost all types of polymer matrices

2. Polymer/layered silicate (PLS) nanocomposites

Traditionally, polymeric materials have been filled with synthetic or natural inorganic compounds in order to improve their properties, or simply to reduce cost. Conventional fillers are materials in the form of particles (e.g. calcium carbonate), fibers (e.g. glass fibers) or plate-shaped particles (e.g. mica). However, although conventionally filled or reinforced polymeric materials are widely used in various fields, it is often reported that the addition of these fillers imparts drawbacks to the resulting materials, such as weight increase, brittleness and opacity [12–15]. Nanocomposites, on the other hand, are a new class of composites, for which at least one dimension of the dispersed particles is in the nanometer range. Depending on howmany dimensions are in the nanometer range, one can distinguish isodimensional nanoparticles when the three dimensions are on the order of nanometers, nanotubes or whiskers when two dimensions are on the nanometer scale and the third is larger, thus forming an elongated structure, and, finally, layered crystals or clays, present in the form of sheets of one to a few nanometers thick and hundreds to thousands nanometers in extent [14]. Among all the potential nanocomposite precursors, those based on clay and layered silicates have been most widely investigated, probably because the starting claymaterials are easily available and because their intercalation chemistry has been studied for a long time [16]. Polymer–layered silicate nanocomposites, which are the subject of the present contribution, are prepared by incorporating finely dispersedlayeredsilicatematerials in a polymer matrix [16-18]. However, the nanolayers are not easily dispersed in most polymers due to their preferred faceto-face stacking in agglomerated tactoids. Dispersion of the tactoids into discrete monolayers is further hindered by the intrinsic incompatibility of hydrophilic layered silicates and hydrophobic engineering plastics. Therefore, layered silicates first need to be organically modified to produce polymer–compatible clay (organoclay). In fact, it has been well-demonstrated that the replacement of the inorganic exchange cations in the cavities or “galleries” of the native clay silicate structure by alkylammonium surfactants can compatibilize the surface chemistry of the clay and a hydrophobic polymer matrix [17]. Thereafter, different approaches can be applied to incorporate the ion-exchanged layered silicates in polymer hosts by in situ polymerization, solution intercalation or simple melt mixing. In any case, nanoparticles are added to the matrix or matrix precursors as 1–100_m powders, containing associated nanoparticles. Engineering the correct interfacial chemistry between nanoparticles and the polymer host, as described previously, is critical but not sufficient to transform the micron-scale compositional heterogeneity of the initial powder into nanoscale homogenization of nanoparticles within a polymeric nanocomposite [18]. Therefore, appropriate conditions have to be established during the nanocomposite preparation stage. The resulting polymer–layered silicates hybrids possess unique properties – typically not shared by their more conventional microscopic counterparts – which are attributed to their nanometer size features and the extraordinarily high surface area of the dispersed clay [14]. In fact, it is well established that dramatic improvements in physical properties, such as tensile strength and modulus, heat distortion temperature (HDT) and gas permeability, can be achieved by adding just a small fraction of clay to a polymer matrix, without impairing the optical homogeneity of the material. Most notable are the unexpected properties obtained fromthe addition of stiff filler to a polymer matrix, e.g. the often reported retention (or even improvement) of the impact strength. Since the weight fraction of the inor ganic additive is typically below 10%, the materials are also lighter than most conventional composites [18–20]. These unique properties make the nanocomposites ideal materials for products ranging from high-barrier packaging for and electronics to strong, heat-resistant automotive components [11]. Additionally, polymer–layered silicate nanocomposites have been proposed as model systems to examine polymer structure and dynamics in confined environments [12,13].

3. Anti hail system

Thunderstorms: there are not funny but for a fruit farmer, they can mean a financial disaster. Even more so when the thunderstorm is accompanied by hail. Because hail makes deep holes in e.g. apples and pear. This way, a fruit farmer can see his whole harvest being destroyed in only a couple of minutes. This is a real catastrophe. Definitely now with the climate changes we will have more trouble with severe storms [21-23]. Per year, big fruit farms suffer approximately 70.000 Euro of damage due to hail. Protection against hail is possible. One can use hail nylon nets, but that is an expensive and labour intensive investment. A better alternative is the anti hail system or hail cannon from polymer nanocomposites. Such a hail nanocomposite-cannon (HNC) generates shock waves and disturbs the atmosphere. A threatening hail storm is thus transformed in rain and the fruit farmer's harvest is being spared. In the 19th century already, Italian farmers used a primitive type of hail cannon with carbide. The Belgian ornamental grower Marnix Van Praet perfected with the lost modern technology [21-25]. So, an anti hail system is not a new phenomenon but a polymeric nanocomposite-cannon, really there is. Today we propose a new solution based on nanotechnology. New nanocomposite-cannon can work with acetylene gas, which together with nitrogen and oxygen can provoke a small explosion. The anti hail system have 3 bottles of acetylene gas that are being injected into a tank and mixed with the turbo engine. Then the gas is being detonated every 7 seconds and thus every 7 seconds there will be a shock wave. All components like connectors, cables, hoses and long light tube should be made of polymer nanocomposites. This will ensure that the system will be more mobile, and cannon can have a different size and shape, which in turn leads to a more protected area. But how can a shock wave counteract hail? Hail develops inside the clouds at a height of 15.000 meters and at a temperature of -50ºC. Super-cooled water drops circulate through areas with different polarities and temperatures. The water drops freeze and form the feared hail that can cause so much damage. But the hail cannon can stop this formation by firing a shock wave every few seconds. The shock wave goes upwards with the speed of sound, which is 334 meters per second. This shock wave will actually mix the positive and negative zones together [21, 23, 26]. So there are different polarities inside a storm cloud that are being mixed. In such a electrically neutral area hail cannot be formed. At the upper side of the cloud, hail can be formed. Water drops are being catapulted upwards by turbulence in the clouds. Temperatures of up to -50ºC cause these water drops to freeze and become hail. This hail falls to the ground and can cause lots of damage. When we shoot in the clouds with the hail nanocomposite-cannon (HNC), the warm and cold air gets mixed. This prevents the rain drops to reach the upper air layers and freeze to hail. Finally, the hail falls to the ground under the form of rain or wet snow. Thus, the hail nanocomposite-cannon (HNC) is very effective way to protect the harvest. But the most important factor got success is the alertness of the person operating the machine. Because the cannon has to be switched on in time in order to get the best possible result. The farmer have to switch on the cannon 20 to 30 minutes beforehand. One cannon protects about 1 km^2, 500 meters to the left and to the right. One km^2 is 80 hectare. So this is ideal to protect vegetable, fruit and cars. When a storm approaches, they receive an short message from the Meteorological Institute [27, 28]. Then farmers will also check the rain radar, and they can look at the same radars as scientists do. Then farmers have to switch on the anti hail system about 20 minutes before the storm reaches us. Keeping a good eye on the weather is the message. But one doesn’t always have to stay nearby to switch on the cannon. The cannon can be switched remotely as well via a mobile phone. Just call, insert a code and the harvest is protected. And not only the harvest. Car companies as well make more and more use of hail cannon. For example Ford Genk uses the hail cannon when an thunderstorm approaches. This saves the car constructor millions of Euros in damage [25-28]. The hail cannon definitely has proven its usefulness over the last years. Hundreds of satisfied farmers confirms this. Especially in Belgium and Holland, there are quite a lot of hail cannons to protect the fruit harvest. But also in Germany, Poland and Hungary, more and more farmers are becoming interested in this advanced nanotechnology.

4. Conclusions

The combination of nanocomposites, polymer engineering and anti hail storm system gives a new meaning on the properties of the product in excess of the existing systems. The advantage of these materials is the lightness, speed of manufacture, low cost of production and the ability to form any desired shape under milder conditions than in the case of metallic materials. Different shapes and sizes working to increase protected area coverage which translates into saving hundreds of millions of euros. These tens of thousands of euros in damage can be avoided thanks to perfected anti hail nanocomposite-cannon. So get rid of the expensive hail polyamide nets and the extremely high insurance premiums. There is a simple solution: the aniti hail system.

Conflict of Interest

The authors declare no conflict of interest

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