Expanded graphite as a reinforcing filler in elastomer technology

Martyna Pingot, Marian Zaborski

Lodz University of Technology, Institute of Polymer and Dye Technology, Stefanowskiego 12/16, Lodz, Poland
Contact: martyna.pingot@gmail.com

Abstract

Graphite is a layered material, which consists of a graphene structures where carbon atoms are bound by covalent bonds to other carbons in the same plane and only van der Waals forces are acting between successive layers. Since the van der Waals forces are relatively weak, it is possible for a wide range of atoms, molecules, and ions to intercalate between graphite sheets. Conventional natural graphite are usually micro-diameter powders. In order to make a composite with satisfactory properties, loadings of filler are usually as high as 20 wt% or even higher. This often results in a material with poor mechanical properties and high density. In order to obtain improved mechanical, thermal and electrical conductive properties the synthesis of expanded graphite was developed.[1-3] Natural graphite is first converted to intercalated or expandable graphite through chemical oxidation in the presence of concentrated sulfuric acid and nitric acid (4:1, v/v). Expanded graphite is then obtained by rapid expansion and exfoliation of expandable graphite in a furnace above 600^0C.[4,5]

The aim of presented work was to obtain elastomer composites exhibiting high mechanical properties, improved air permeability and electrical conductive properties. The expanded graphite was obtained from acid intercalated graphite Grafguard 160-80N (Graftech) by the means of thermal expansion at high temperature. As an elastomer matrix the acrylonitrile-butadiene rubber (NBR) was used. In order to improve dispersion of the filler, several types of dispersing agents were used: anionic, cationic, nonionic and ionic liquids. The fillers were characterized by dibutylphtalate absorption analysis, aggregates size and rheological properties of filler suspensions. The compounding was carried out in a laboratory Brabender Mixer. Samples were prepared through the vulcanization process at 160^0C. The vulcanization kinetics of rubber compounds, crosslink density, mechanical properties, hysteresis under stretching, conductive properties of vulcanizates and the Payne effect analysis under shearing were also measured. In order to characterize filler dispersion in elastomer matrix the SEM images were obtained (Fig. 1). To enhance the degree of interphase boundary, the graphite layers separation was conducted in polar solvents by the means of ultrasonic waves. As a result the partial graphite exfoliation was observed. The estimated thickness of stacked graphene layers is below 50 nm.

References

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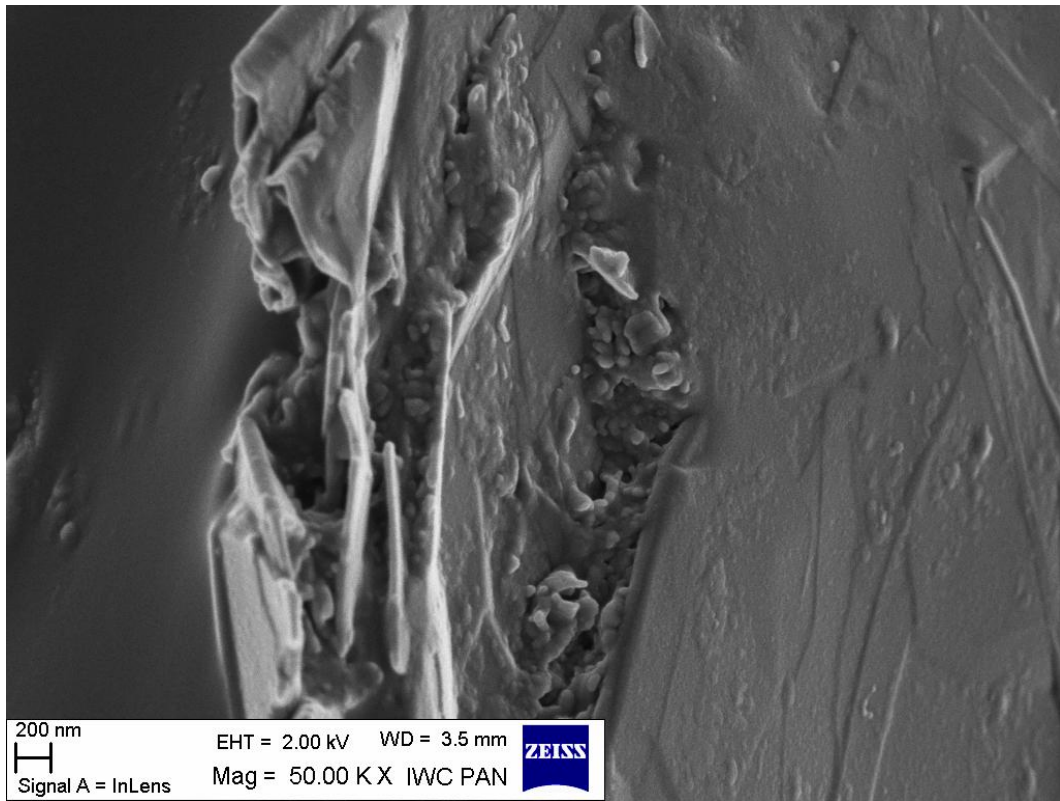[5] Drzal L.T., Fukushima H., Polym. Prep., **42(2)** (2001) 42.

Fig.1. SEM image of NBR composite containing 10 phr of expanded graphite showing the intercalated graphite layers with elastomer matrix.