How the shape of fillers affects the barrier properties of polymer/ non-porous particles nanocomposites: A review

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How the shape of fillers affects the barrier properties of polymer/ non-porous particles nanocomposites: A review

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Abstract:

More than 1000 published experimental data of gas (O_2 and CO_2) and vapor (H_2O) permeability in nanocomposites containing either spherical, elongated or platelet particles were collected, assorted and compared in order to decipher the role of particle shape on the reduction of the relative permeability of the nanocomposite. It is well known that inclusion of homogeneously dispersed and oriented impermeable fillers with high aspect ratio, such as platelets or elongated particles, should significantly increase the diffusion path of gas and vapors and yield to improve barrier properties. Results revealed that this expected impact was not systematically achieved, even for impermeable lamellar fillers that usually displayed the highest aspect ratio. More specifically, an unexpected increase of the permeability in the nanocomposite was often observed. To explain this deviation of the 'ideal behavior', this paper discusses extensively the impact of the nanoparticle shape on the nanocomposite permeability along with structural aspects, related to both the particle nature and size, and the nanocomposite processing routes. Deviations from expected results of enhanced barrier effect are also discussed in correlation with unexpected variations in gas selectivity for O_2/CO_2 pair. Lastly, this review aims at drawing meaningful conclusions on the structure/mass transfer relationships and giving directions for the development of the next generation of packaging materials with tailored mass transfer properties.

Keywords:

Particle shape, Nanocomposites, Structure & mass transfer relationships, Permeability