Influence of the cohesion between polymer chains on the structure and the electrical properties of polyaniline and polypyrrole nanocomposites with zeolite and ZnO

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The intercalation of conductive polyaniline (PANI) and polypyrrole (PPy) chains in zeolite galleries, a few nanometers wide, allows obtaining composite materials with significantly improved mechanical properties, thermal and chemical stability [1]. These nanocomposites can find application in hydrogen storage, solid electrolyte cells, chemical gas or pH sensors, membranes, fabrication of molecular wires, etc. Moreover, PANI and PPy combined with ZnO can make composite polymer/insulating materials suitable for solar cells [1-3].

In PANI there is a strong very short ≈ 2.45 Å hydrogen bond between neighboring chains, making PANI semicrystalline, though in PPy weak van der Waals forces hold together the aromatic groups at a distance of of ≈ 3.42 Å making the polymer amorphous [4].

In the PANI/zeolite composites the conductivity and thermal stability remain practically unchanged with increasing zeolite content. On the contrary, in PPy/zeolite composites these properties improve with increasing zeolite concentration. Moreover, SEM images and XRD patterns of PANI/ZnO composites reveal that a number of the ZnO particles are expelled from the matrix, although in PPy/ZnO composites ZnO is completely encapsulated into the polymer. These differences are attributed to the stronger bond between PANI chains which justify the formation of crystalline conductive grains in it in contrast to the much weaker packing of polymer chains in amorphous PPy.

The difficulty of monomer diffusion, the much slower polymerization and the powerful mutual attachment of the PANI chains minimize the growth of them into the zeolite galleries. On the other hand, the more loosely attached PPy chains penetrate more easily the nanopores of the zeolite. So, a greater number of the former disorderly arranged PPy chains become aligned increasing the electrical conductivity and making the composites more resistant to aging.

In the case of the PANI/ZnO composites the strong attachment of the polymer chains, expels a number of the zeolite particles from the composite matrix. On the contrary, PPy with the weaker bonds between the chains can encapsulate a much greater number of ZnO particles inside it.

References

[1] Shakoor, Rizvi and Hina, J. Appl. Polym. Sci. 124, 3434 (2012).
[2] Dalas, Vitoratos, Sakkopoulos and Malkaj, J. Power Sources 128, 319 (2004).
[3] Vitoratos, Sakkopoulos, Dalas, Malkaj and Anestis, Curr. Appl. Phys. 7, 578 (2007).
[4] Colomban, Gruger, Novak and Régis, J. Mol. Struct. 317, 261 (1994).

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