Semana de Engenharia 2010
Guimarães, 11 a 15 de Outubro

NANOMATERIALS FOR WATER TREATEMNT

M. Oliveira[1], A. V. Machado[1], R. Nogueira[2]

[1]Department of Polymer Engineering and I3N, University of Minho, Campus de Azurém, 4800–058 Guimarães, Portugal

[2]IBB – Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, University of Minho, Campus de Gualtar, 4710–057 Braga, Portugal

The German agriculture chemist Justus von Liebig, in 1855, demonstrated that growth yields of terrestrial plants can be limited by the nutrient least quantity in environment relative to plant demands growth (1). Among many inorganic nutrients requires for plants growth, phosphorus (P) is one of the principal limiting nutrient. This rule is not restricted for terrestrial ecosystems the same occurred to aquatic. Phosphorus influences strongly the growth of algae and vascular plants in freshwater and marine ecosystems. Several nutrient classifications have been tried to assess the nutrient concentration in aquatic mediums. Premazzi and Cardoso reported in 2001, which the most part of European States had been using OECD (1982) criteria to establish the trophic categories. As the limits for three trophic state categories in reservoirs and lakes: oligotrophic (< 10 µgP/L); mesotrophic (10-35 µgP/L) and eutrophic (> 35 µgP/L).

Excessive nutrients concentration has many effects on biology, chemistry and human use of lakes and rivers. Eutrophic water bodies have in general aesthetic problems, undesirable odor, colour and taste (figure 1). In severe cases toxins might also be present in the water resulting from the dominance of phytoplankton by blue-green algae (cyanobacteria), whereas some of which produce compounds more toxic than cobra venom (2).

Figure 1 – Eutrophication of fresh water.

Until now, many solutions have been tried to reduce the excess of phosphorus, but with limited success. The most often used, consist in the direct application of the metal salts. This type of approach has several disadvantages, for example, isn't possible recovery the chemical applied, contaminated water with heavy metal, increased the turbidity and change the physical-chemical water parameters (like pH and redox potential). Moreover, parallels reaction occurred, which can consume part of chemical, being necessary to apply overdoses of the chemical to guarantee the desired removal degrees (3). For these reasons, is imperative to develop a new product able to overcome all these disadvantages.

Following this sequence, hybrid polymers seems to be a good alternative. The organic-inorganic hybrids have been increasing the academic interest, due to its unique properties. The combination of organic and inorganic structures at molecular level forms a nanocomposite, with enhanced properties. These could not be achieved by other materials, opening this away new windows of applications (figure 2).

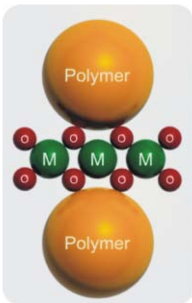

Figure 2 – Scheme of hybrid material structure.

High ductility, low temperature processing, high modulus, thermal stability and low coefficient of thermal expansion are some of the properties this type of materials. Such materials have several applications, like as optics, electronic, mechanics, protective coatings, catalysis, sensors, membranes, etc. According with literature review, there are two types of organic-inorganic hybrid materials. The first one, the organic and inorganic components are connected mainly by weak hydrogen bonds or van der Waals forces. The second one, organic and inorganic components are connected by strong chemical bonds, covalent or iono-covalent. In this type of hybrids, molecular motions are restricted and consequently the thermomechanical properties are improve (4).

The present work aims to develop a hybrid polymer based on polypropylene able to remove phosphorus from contaminated water. Since aluminium is very efficient on phosphorus removal, it was selected as the inorganic constituent being a alkoxide metal. The chemical structure and the physical properties of the prepared nanocomposite were characterized using several techniques (FT IR, Rheology, TGA/DSC, SEM/TEM and XPS). Using this approach it was possible to develop a new material with the required properties (figure 3).

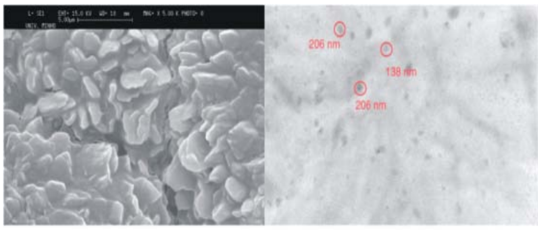

Figure 3 – SEM and TEM pictures of hybrid polymer developed.

Bibliography

Bounor-Legaré, V.; Angelloz, C.; Blanc, P.; Cassagnau, P. and Michel, A. 2004. "A new route for organic-inorganic hybrid material synthesis through reactive processing without solvent." *Polymer*, 45, 1485 - 1493.

Hano, T.; Takanashi, H.; Hirata, M.; Urano, K. and Eto, S. 1997. "Removal of phosphorus from wastewater by activated alumina adsorbent." *Water Science Technology*, 35, 39 - 46.

Skulberg, O.M.; Codd, G.A. and Carmichael, W.W. 1984. "Toxic blue-green algal blooms in Europe: a growing problem." *Ambio*, 13, 244 - 247.

von Liebig, J. 1855. "Principles of agricultural chemistry with special reference to the late researches made in England." In: Pomeroy, L.R. (Ed.), Cycles of Essential Elements. Benchmark Papers in Ecology, Vol. 1. Dowden, Hutchinson, and Ross, UK, pp. 11 - 28.

Author Biography

Manuel Oliveira went to Minho University to study Chemistry – Quality Control and obteined his degree in 2006. After, for two years, he worked in water treatment, starting her Ph.D. in the same subject in 2008.

E-mail address: moliveira@dep.uminho.pt