SiO_2/PLGA HYBRID NANOCOMPOSITES

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INTRODUCTION

Recently, much attention has been devoted to the developing of a new class of advanced materials - hybrid organic-inorganic nanocomposites. These composites have a wide range of potential applications, and one of them is the removal of heavy metals from industrial waters. Such hybrids include two parts: the inorganic part contributes to the stability of materials in water and solvents (silica), while the organic part (polymer) is chosen to add specific chemical properties (PLGA).

AIM

Development of synthesis approaches and optimization of the most favorable conditions to obtain hybrid materials on the basis of inorganic (SiO_2) and organic (polymer) components by sol-gel method; investigation of their composition, the structure, and the adsorption properties to heavy metal ions from model solutions.

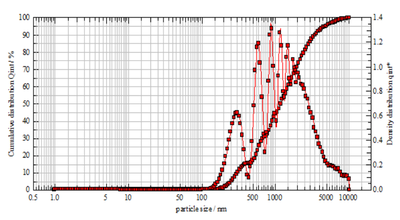
MATERIALS AND METHODS

The synthesis of such composites was carried out in acetone. Tetraethyl orthosilicate (TEOS) was applied as a silica source, PLGA (poly(lactic acid-co-glycolic acid) was taken as the polymer component. Firstly, TEOS was prehydrolyzed with HCl. After that, the different catalysts were used (NaF, NH_4OH) for the mixture with a polymer. As well as ethylene glycol (EG) as a crosslinking agent was added in the synthesis procedure with NaOH as the catalyst.

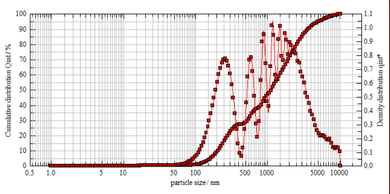
The syntheses were realized by a one-step sol-gel method. The composition and structure of the hybrid materials were determined by CNHS analysis, acid-base titration, zeta potential measuring, IR spectroscopy, TGA, low-temperature nitrogen adsorption method and SEM.

PHOTON CROSS-CORRELATION SPECTROSCOPY

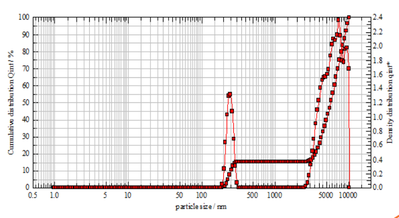
According to photon cross-correlation spectroscopy Fig. 2, **TP1**, **TP2** and **TPE3** sample are composed of 200 and 500 nm spherical particles.



TP1



TPE3



TP2

SYNTHESIS

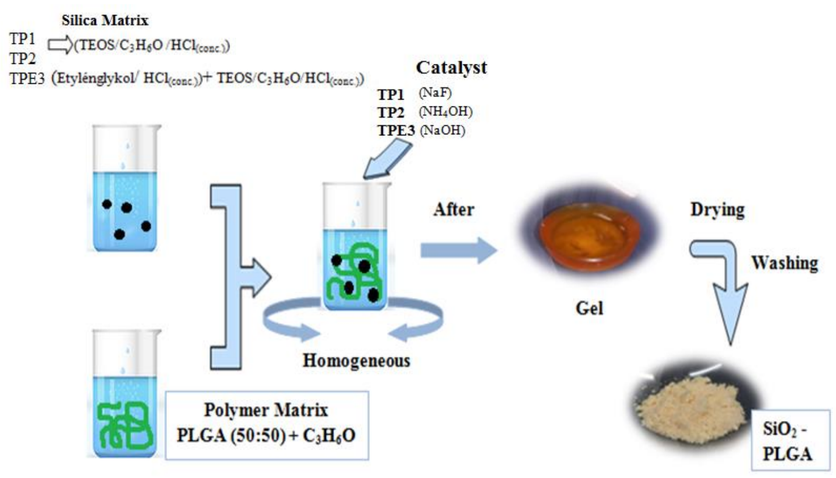


Fig.1. Sol-gel technique to produce silica-polymer materials in acetone

IR-SPECTROSCOPY

Fig.3 shows the FT-IR spectra of the PLGA/ TEOS composites. The observed absorption bands can be interpreted, according to literature data, as follows: the band at 1074-1087 cm^{-1} is attributed to the asymmetric and symmetric stretching vibrations of the O–Si–O, as well as ≡SiO-R (1169-1191 cm^{-1}) which may mean co-condensation between the two components in such hybrids. Also, represented bands (2823-2989cm^{-1}) of the main functional groups of polymer.

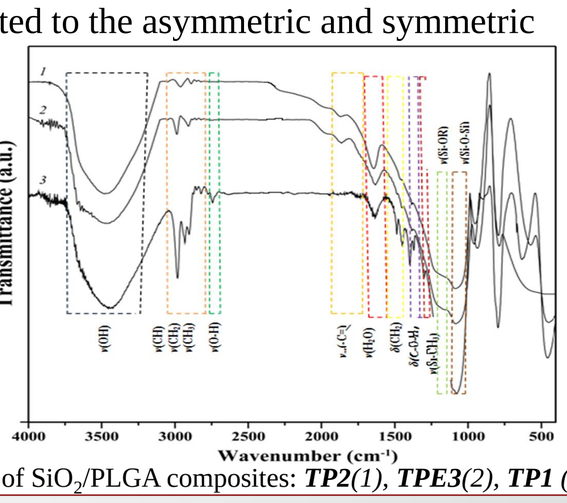
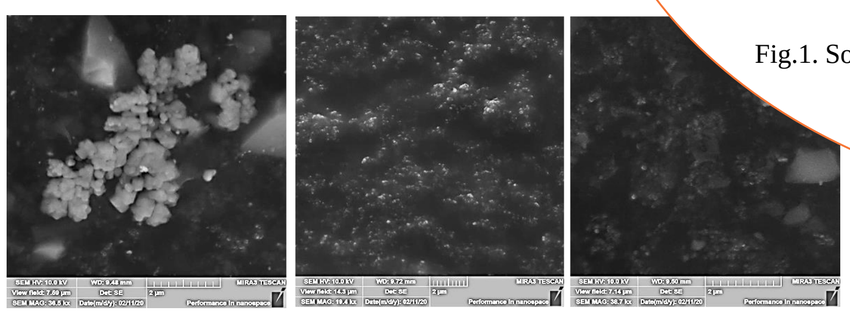


Fig. 3.IR spectra of SiO_2/PLGA composites: ***TP2****(1)*, ***TPE3****(2)*, ***TP1*** *(3)*.

SEM

SEM images of the obtained composite materials reflect the particle size and morphology of PLGA/TEOS composites. In Fig.4 show that the samples ***TP1, TP2,*** and ***TPE3*** have typical morphology as silica gels with irregularly shaped particles sometimes spherical ones.



TP1 **TP2** **TPE3**

SORPTION PROPERTIES

It has been found that these materials selectively adsorb up to ~50% of iron (III) ions from a mixture of metals containing ~20 mg/l of copper (II), manganese (II), nickel (II) and iron (III) ions.

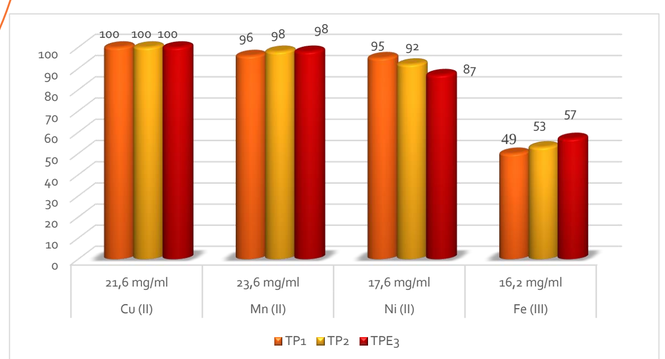


Figure 5. Data of adsorption efficiency of metal ions from the mixture for ***TP1***, ***TP2*** and ***TPE3*** samples

CONCLUSIONS

- Hybrid materials were synthesized by the sol-gel method using various catalysts at the same condition and component ratio.
- IR spectroscopy confirms the formation of ≡Si-O-Si≡bonds, the presence of PLGA in matrix as well as the interaction between organic and inorganic components.
- It was shown that the synthesized materials have acid groups on the surface in the 4.6-5.6 mmol/g.
- Using TEOS and PLGA lead to form non-porous xerogels, but introducing cross-linking agent (ethylene glycol) could change the porosity of the obtained materials.
- These hybrids could be used as adsorbents for selective removal of Fe(III) ions from metal ions mixture.

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