

SYNTHESIS OF MAGNETIC NANOPARTICLES WITH SURFACE MODIFIED WITH CHITOSAN AND POLY (ACRYLIC ACID) BLENDS FOR BIOMEDICAL APPLICATION

Katarzyna Węgrzynowska-Drzymalska^a, Dorota Chełminiak-Dudkiewicz^a, Marta Ziegler-Borowska^a, Adam Sikora^b, Halina Kaczmarek^a, Michał P. Marszałł^b

^aNicolaus Copernicus University in Toruń, Faculty of Chemistry, Department of Polymer Chemistry and Photochemistry, Gagarina 7, 87-100 Torun, Poland

^bFaculty of Pharmacy, Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Dr Jurasza 2, 85-089 Bydgoszcz, Poland

INTRODUCTION

In recent years, the synthesis and characterization of nanoparticles has been the focus of intensive research. Particularly interesting are biochemically functionalized nanoparticles which can be used in many various biomedical applications. This is mainly due to their specific properties, which are small size, biocompatibility, wide chemical affinity, and non-toxicity. A special class of this type of nanomaterials are magnetic nanoparticles, based on magnetite (Fe_3O_4), showing superparamagnetic properties (Fig. 1.) [1].

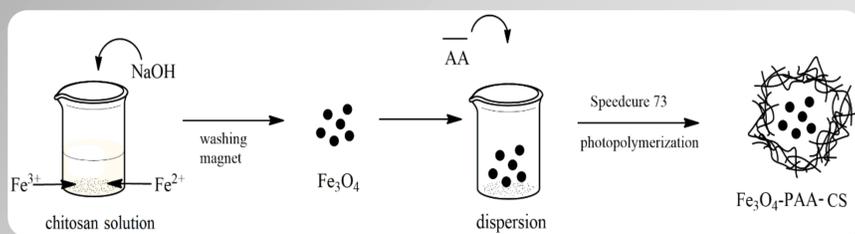


Fig. 1. The scheme of preparation of Fe_3O_4 -PAA nanoparticles.

Magnetite nanoparticles have been highly employed in biomedical applications such as magnetic hyperthermia, catalysis, diagnostic agent, and especially for biomolecule immobilization [2]. The action and properties of the magnetic materials depend on the stabilizer type, covering their surface. An example of nanoparticle stabilizer are poly(acrylic acid) (PAA) and chitosan (CS).

FTIR SPECTROSCOPY

The band at 1635 cm^{-1} , corresponding to the C=C vibrations, has been selected for the analysis and calculation of conversion degree of monomer (X,%). The gradual disappearance of this band, observed during UV exposure of the sample, illustrates the progress of polymerization. The plot of X versus irradiation time clearly indicates three steps of reaction (Fig. 5.). The first one, at the time of 0–120 s, is an induction period wherein the polymerization is negligible. Actual rapid curing is observed in the second stage, i.e. during 120–160 s of UV exposure. Finally, the third step during the subsequent 40 s, significantly slower ($R_p=0.2183$), results in nearly complete conversion of the monomer (X=98%).

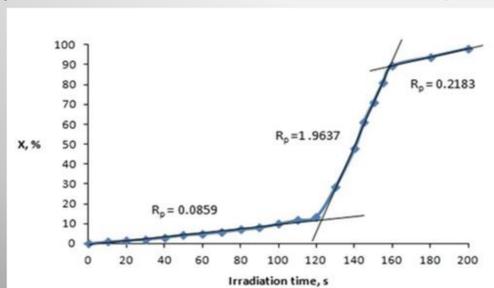


Fig. 5. The kinetics of acrylic acid photopolymerization in air atmosphere.

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References:

- [1] Chełminiak D., Ziegler-Borowska M., Kaczmarek H., *Synthesis of magnetite nanoparticles coated with poly(acrylic acid) by photopolymerization*, Materials Letters 164 (2016) 464-467,
[2] Ziegler-Borowska M., Chełminiak D., Siódmiak T., Sikora A., Marszałł M.P., Kaczmarek H., *Synthesis of new chitosan coated magnetic nanoparticles with surface modified with long-distanced amino groups as a support for bioligands binding*, Materials Letters 132 (2014) 63-65.

ENANTIOSELECTIVE ACETYLATION OF (R,S)-ATENOLOL

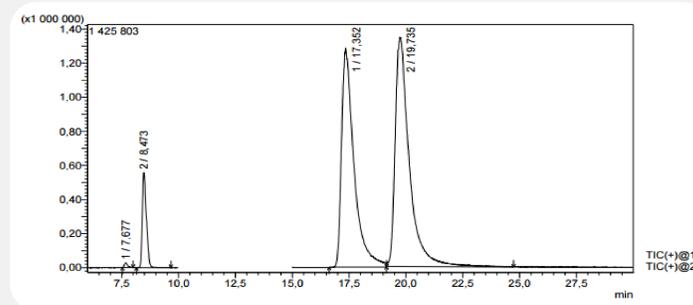


Fig. 2. Chromatogram of racemic atenolol and its esters after 192h of kinetic resolution of (R,S)-atenolol.

TEM ANALYSIS

The morphology of magnetite nanoparticles coated with poly(acrylic acid) by photopolymerization has been investigated by HR-TEM (Fig. 3.). The estimated diameter of the nanomaterials was about 6-13 nm.

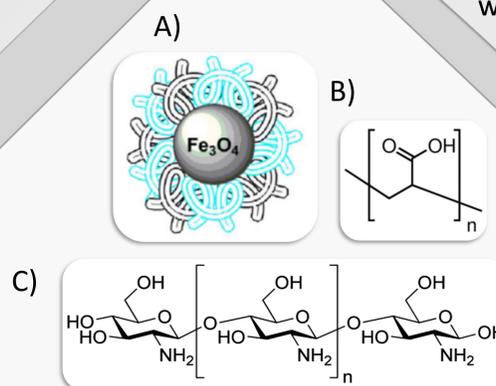


Fig. 4. Structure of:
A) magnetite nanoparticles coated with chitosan and poly(acrylic acid),
B) poly (acrylic acid),
C) chitosan.

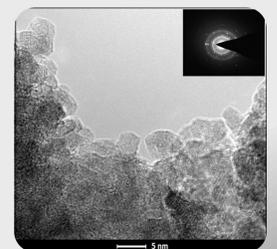
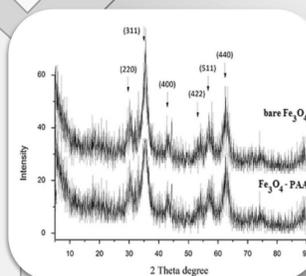


Fig. 3. HR-TEM image of Fe_3O_4 -PAA nanoparticles.

XRD ANALYSIS

The XRD analysis shows six characteristic for magnetite signals at 30° , 35° , 43° , 53° , 57° , and 62° marked by their indices: (2 2 0), (3 1 1), (4 0 0), (4 2 2), (5 1 1), and (4 4 0) (Fig. 6.).



These peaks reveal that the nanoparticles core was a pure magnetite of spinel structure and the structure of Fe_3O_4 is not changed during the synthesis process.

Fig. 6. X-ray diffraction pattern of Fe_3O_4 -PAA nanoparticle.

CONCLUSION

The simple and fast method of preparation of the magnetite nanoparticles coated with poly(acrylic acid) and chitosan in air atmosphere and at room temperature was presented. The crosslinked coating ensures the stability of magnetite nanoparticles in aqueous solutions. The chemical structures of Fe_3O_4 -PAA and Fe_3O_4 -PAA-CS nanoparticles studied by FTIR. XRD confirmed that coating process was successful and magnetite core was unchanged. HR-TEM supplied information on the size of magnetic nanoparticles which was extremely low (6-13 nm). The content of magnetite in the nanoparticles was very high (81%), which is unreachable by any other conventional coating method (e.g., by polymerization at elevated temperature).