

# Analysis of polypyrrole nanoparticles as possible components for array technology

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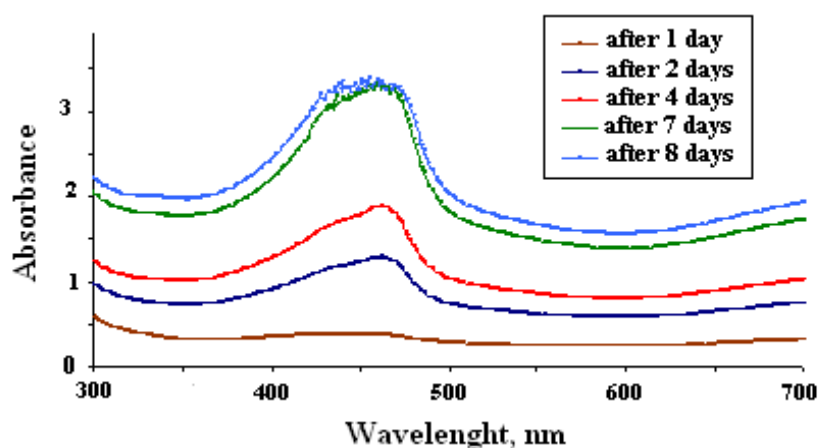
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Recently, nano-science and nano-technology became one of the up-to-date topics in different fields of research such as physics, chemistry, biology and medicine. Among various conducting polymers, polypyrrole (Ppy) has been the most widely studied material for potential biomedical applications mainly because of its relatively high environmental stability, versatile electrical properties, and because this polymer can be easily synthesized chemically in the form of micro- and even nano- particles as well as electrochemically synthesized in the form of thin micro- and nano- films that can be deposited on various electrodes from aqueous media.

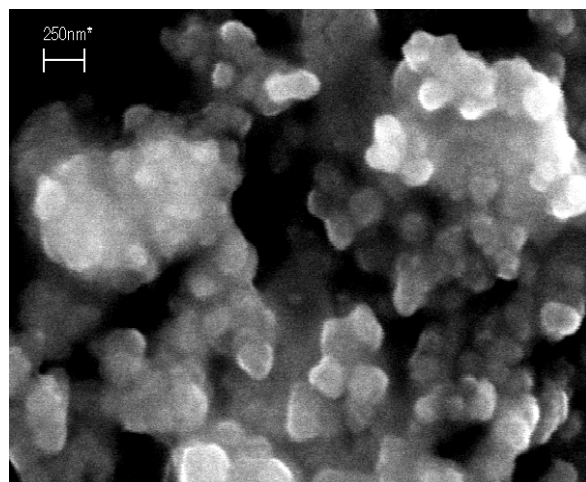
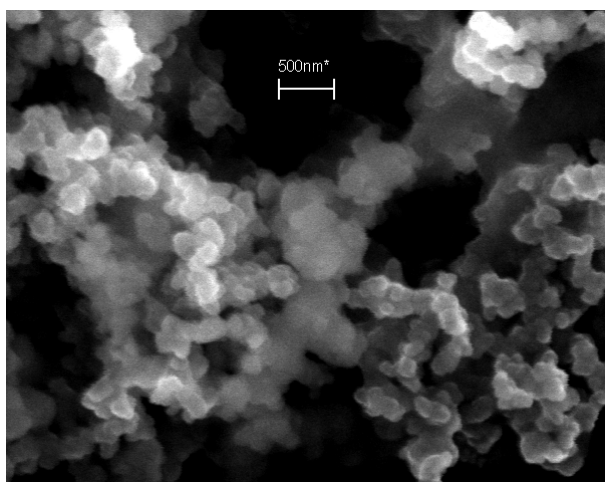
Polypyrrole based nanoparticles belong to a unique class of materials with potential application in optical/visual immunodiagnostic assays and array technology due to their deep black colour and intense optical absorbance. The facile preparation of polypyrrole in aqueous media and its surface modification by charged functional groups makes this polymer particularly suitable for the immobilization of proteins and DNA making this polymer interesting for biomedical applications.



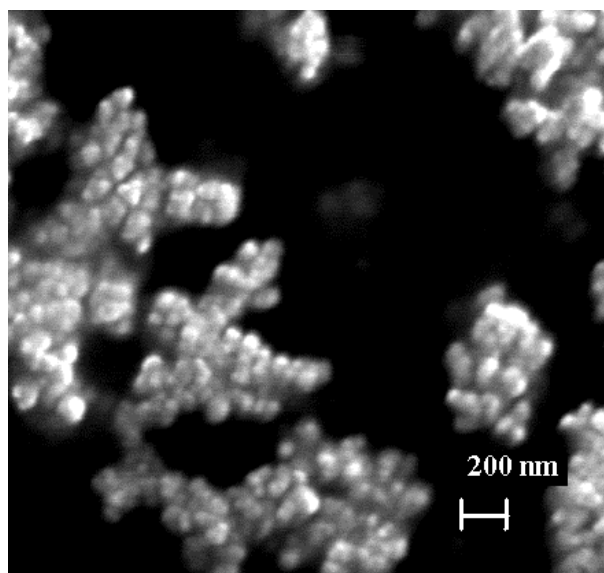
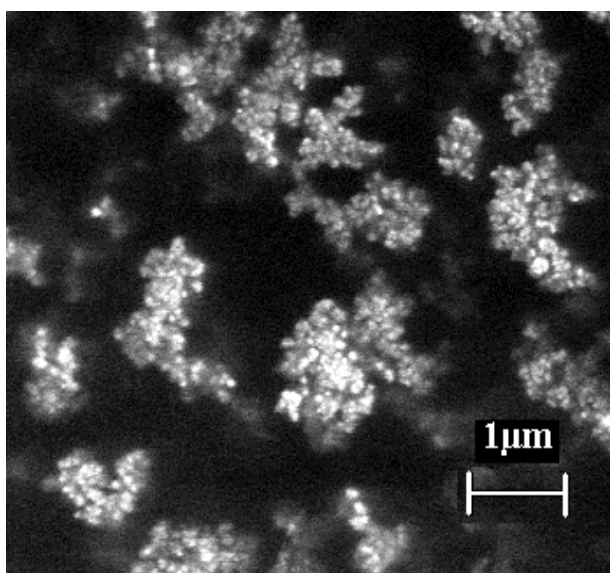
UV-vis spectra of polypyrrole formation in mixture of sodium acetate and potassium phosphate buffer at pH 2, containing pyrrole and H<sub>2</sub>O<sub>2</sub>.

Polypyrrole particles can readily be prepared in aqueous solutions by chemical oxidative agents  $\text{FeCl}_3$ ,  $\text{Fe}(\text{NO}_3)_3$ ,  $(\text{NH}_4)_2\text{S}_2\text{O}_8$  initiated polymerization, and formed Ppy particles appears in size ranging from 200 nm up to 450 nm.

In our study Ppy particles were chemically synthesized using two other oxidation agents possessing different oxidation potential, hydrogen peroxide (exhibiting lower oxidation capacity) and potassium bichromate (exhibiting higher oxidation capacity). Polypyrrole based fluorescence quenching was registered by home made luminescence spectrometer. Scanning electron microscope (SEM) was used for the analysis of Ppy particles size.

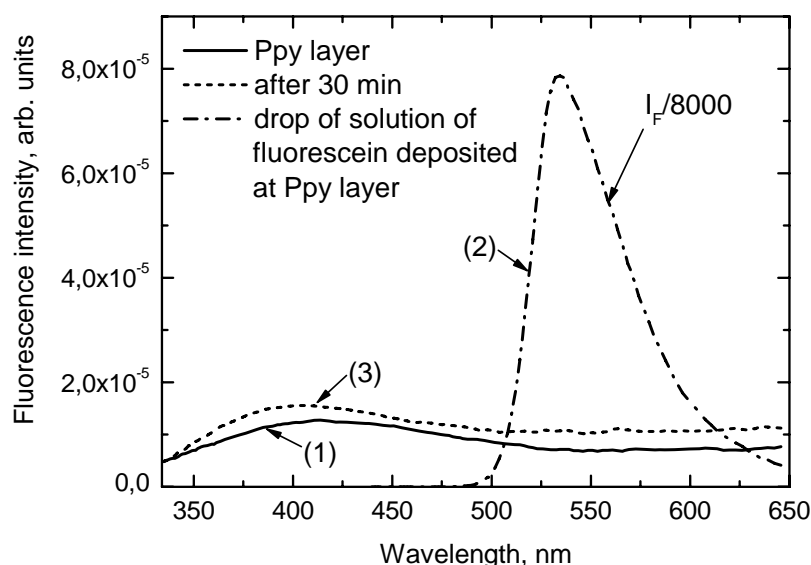


SEM (EVO 50 XVP, Carl Zeiss SMTP) image of Ppy particles synthesized using  $\text{K}_2\text{Cr}_2\text{O}_7$ . The Ppy particles are about 140-180 nm and are susceptible to form 1  $\mu\text{m}$  aggregates.

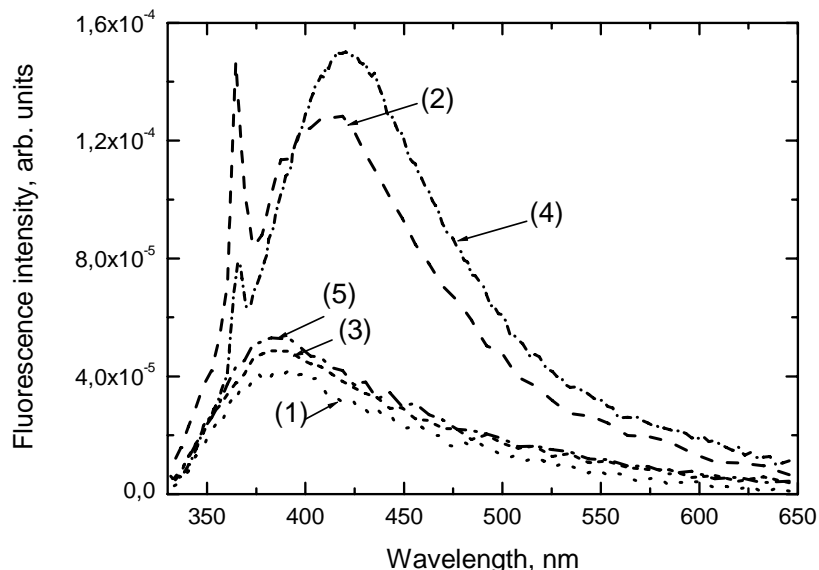


SEM (EVO 50 XVP, Carl Zeiss SMTP) image of Ppy particles synthesized using  $\text{H}_2\text{O}_2$ . The Ppy particles are about 40-60 nm and are susceptible to form 1  $\mu\text{m}$  aggregates.

Our results show that polypyrrole itself is not fluorescent material and quenches any fluorescence if the fluorescent agents are enough close to Ppy surface.



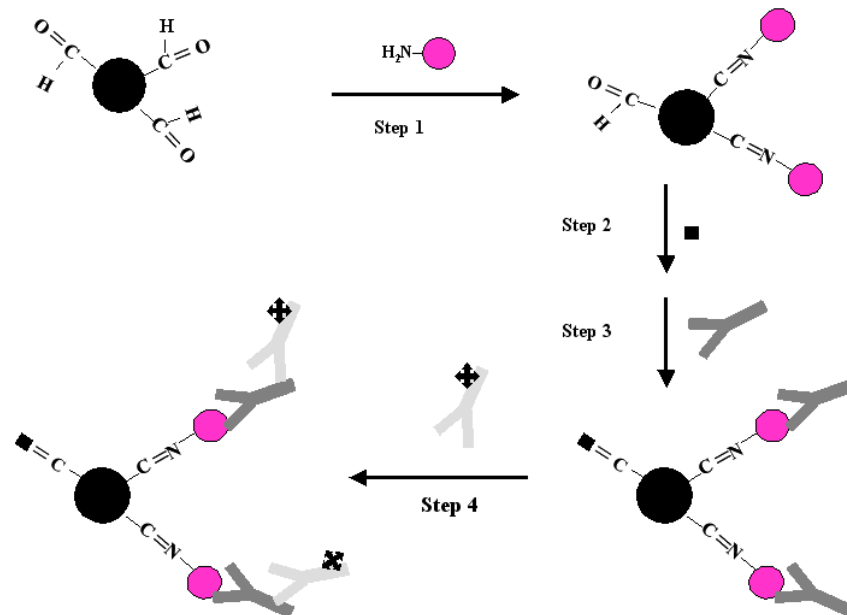
Study of polypyrrole as fluorescence quencher. The fluorescence spectra of *gp51*/Ppy layer (1) before treatment; (2) after 30 min incubation in solution of fluoresceine, with solution drop; (3) after *gp51*/Ppy layer was dried (in the last curve  $I_F$  is divided by 8000 times to fit this curve into presented figure).



Study of polypyrrole as fluorescence quencher. The fluorescence spectra of *gp51*/Ppy layer (1) before treatment; (2) with 2 µl drop of Ab\* solution; (3) after the solvent was evaporated; (4) after second addition 2 µl drop of Ab\* solution before *gp51*/Ppy layer was dried; (5) after the solvent was evaporated for the second time.

Ppy particles differ in size and it depends on oxidizing agent: particles synthesized using  $H_2O_2$  is smaller (about 40-60 nm) if compare with  $K_2Cr_2O_7$  synthesized ones (about 140-180 nm).

Particles synthesized with  $K_2Cr_2O_7$  and additionally oxidized by  $K_2Cr_2O_7$  prior to immobilization are more suitable for protein covalent immobilization if compared with those not additionally oxidized by  $K_2Cr_2O_7$ .



Schematic diagram showing the protein *gp* 51 immobilization and further specific interaction with specific and secondary labelled antibodies (protein *gp*51–  $H_2N$ --●; ethanolamine–■; specific antibody – Y; secondary labelled antibody – Y●)

The possibility to apply Ppy particles modified by bovine leukemia virus protein to detect specific antibodies in the serum of infected animals might be predicted from results presented.

Ramanavičius A., Mostovojus V., Kaušaitė A., Lapėnaitė I., Finkelšteinas A., Ramanavičienė A. (2006) Chemical oxidative synthesis of polypyrrole particles and functionalization by proteins. *Biologija* 3: 43-46.).