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ELECTROCHEMICAL DETECTION OF URANYL IONS USING MODIFIED PET TRACK-ETCHED MEMBRANES

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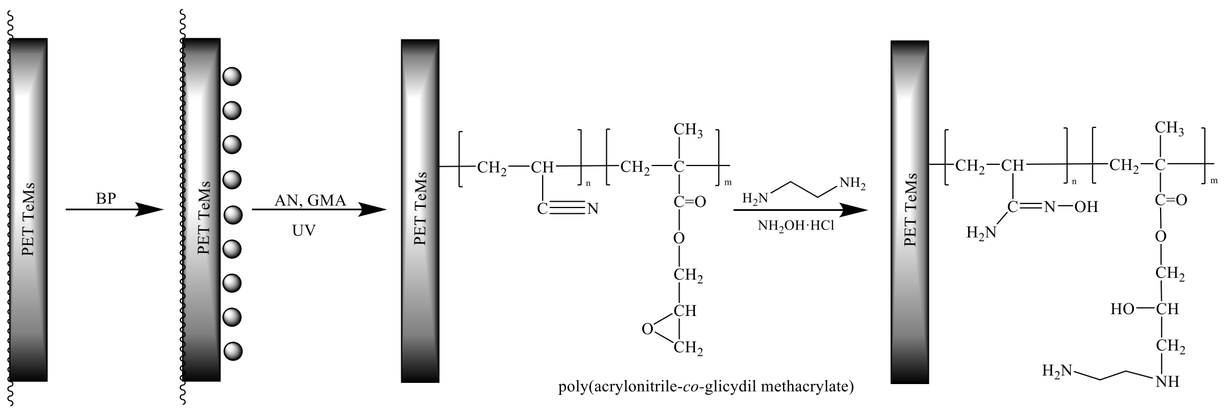
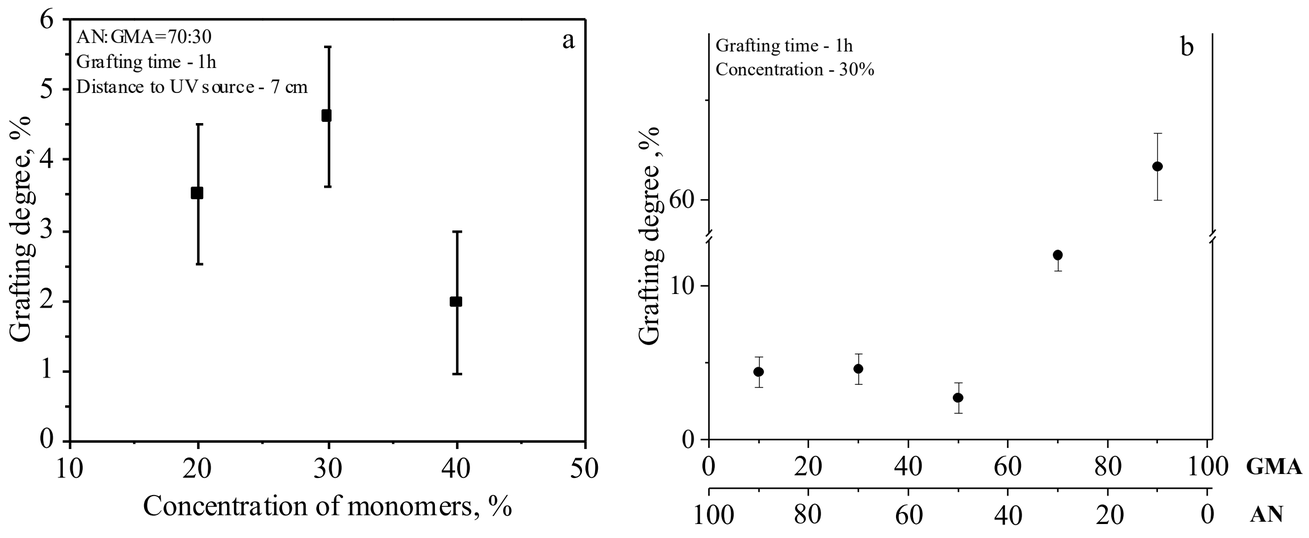
ABSTRACT AND INTRODUCTION

Uranium and their compounds are harmful to human health and with rapid development of nuclear industry, development of fast and reliable method of detection of uranium in the environment has become relevant task. In this research, we present the results of preparation of electrochemical sensor based on poly(ethylene terephthalate) ion-track membranes (PET TeMs) for sensing of uranium in water. Graft (co)polymerization of glycidyl methacrylate (GMA) and acrylonitrile (AN) and subsequent polymer analogous reactions of grafted chains with formation of amino and amidoxime groups allow us to obtain sensors with LOD of up to 5.45 μg/L (R2 = 0.9981, linear relationship in in concentration range from 1 to 100 μg/L) for PET TeMs-g-PAN/PGMA using square wave anodic stripping voltammetry (SW-ASV). The influence of the type of grafted polymer on the sensitivity of sensors was also studied. Optimal parameters that led to functionalization of the surface by photo-induced grafting with preservation of the pore structure were found. Morphology and pore size of the membranes were evaluated by scanning electron microscopy (SEM) and atomic force microscopy (AFM), gas permeability test. Chemical changes on the membrane were proven by infrared spectroscopy (FTIR).

RESULTS AND DISCUSSION

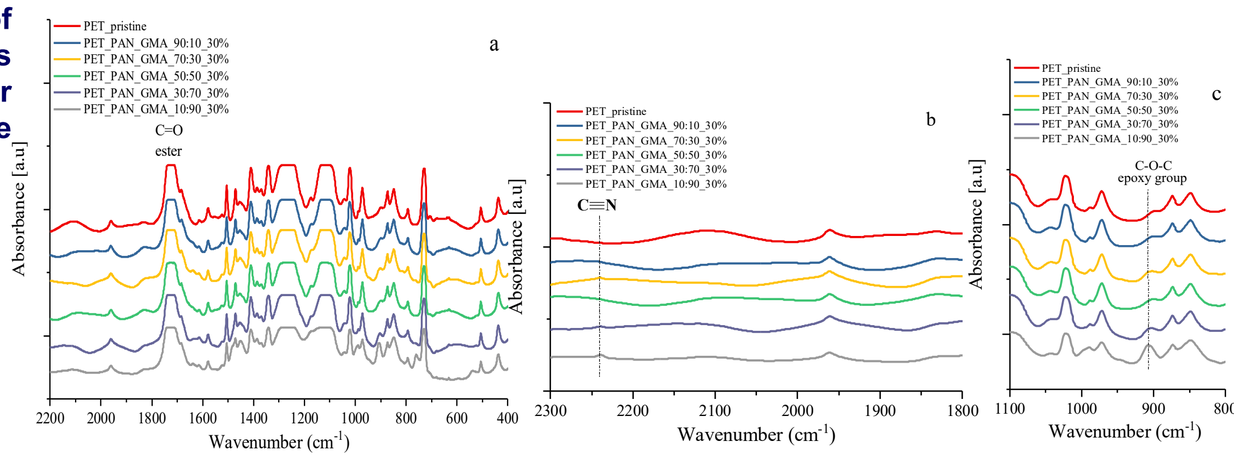
PET TeMs were modified according to the scheme. At the first stage, graft polymerization of AN, GMA was performed. Then, polymer analogous reactions of grafted chains with formation of amino and amidoxime groups on modified PET TeMs was performed. Parameters that can influence to the grafting degree such as monomer concentration, reaction time and distance from the UV-lamp were optimized to get the highest grafting degree with maintaining the pore structure of the membranes.

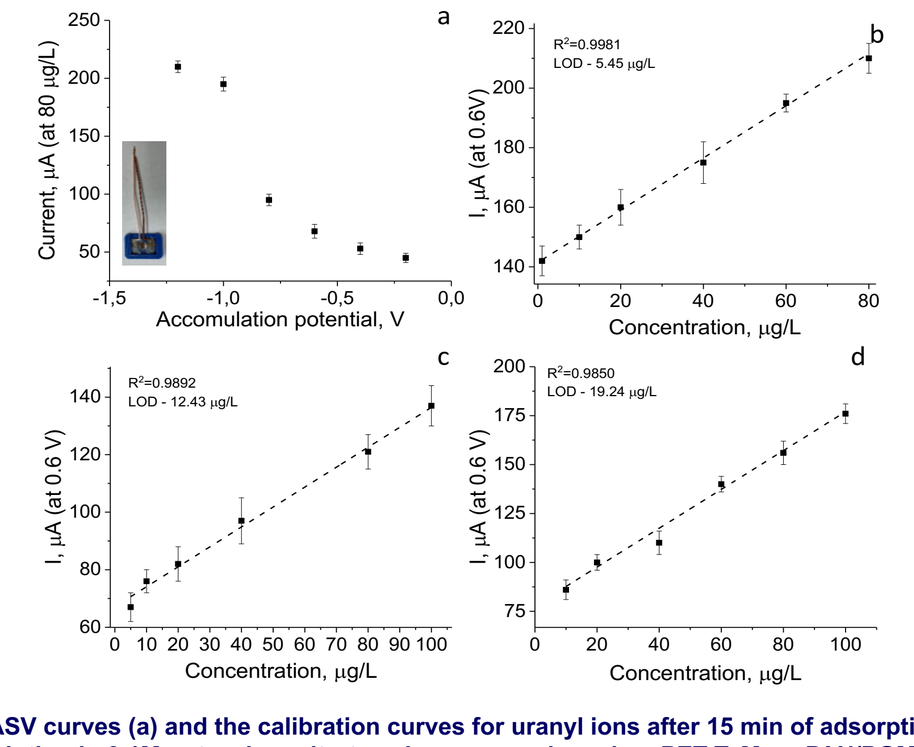




Grafting degree depends on monomer concentration (a), monomer ratio (b)

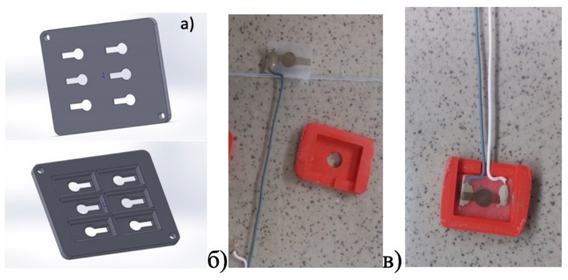
ATR-FTIR spectra of modified membranes:





Typical SW-ASV curves (a) and the calibration curves for uranyl ions after 15 min of adsorption in the appropriate solution in 0.1M potassium nitrate using sensors based on PET TeMs-g-PAN/PGMA (b), PET TeMs-g-PAN (c) and PET TeMs-g-PGMA (d)

Mask for sputtering of a conductive layer (a), membrane after deposition using a mask (b), sensor with soldered wires in a holder (c).



CONCLUSION

We demonstrated that graft copolymerization of acrylonitrile and glycidyl methacrylate and subsequent polymer analogous reactions of grafted chains with formation of amino and amidoxime groups on poly(ethylene terephthalate) track-etched membranes can enhance properties of electrochemical sensors prepared based on this modified membranes. Prepared sensors were used for electrochemical detection of U ions using square-wave anodic stripping voltammetry in the concentration range from 1 to 100 μg/L. The detection limit for sensors modified with copolymer PAN/PGMA is 5.45 μg/L (R2 = 0.9981).

REFERENCES

I. V. Korolkov, A. B. Yeszhanov, A.Kh. Shakayeva, D.I.Shlimas, A. Zhumazhanova, M.V. Zdorovets. Photo-induced graft (co)polymerization of glycidyl methacrylate and acrylonitrile on PET ion-track membranes for electrochemical detection of uranyl ions // Colloids and Surfaces A:Physicochemical and Engineering Aspects. – 2022, https://doi.org/10.1016/j.colsurfa.2022.129086

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