

# 8th EUROPEAN CONFERENCE ON & PESTICIDES AND RELATED ORGANIC MICROPOLLUTANTS IN THE ENVIRONMENT 14th SYMPOSIUM ON CHEMISTRY AND FATE OF MODERN PESTICIDES

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**Ioannina, Greece**

**September 18-21, 2014**

**"Karloos Papoulas"**

Conference Center

**University of Ioannina**

## FINAL PROGRAMME

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ASSOCIATION FOR ENVIRONMENTAL  
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1964 - 2014 Celebrating the



**50TH ANNIVERSARY  
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**PP32**

ACT1074

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ACT1074

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ACT1093

**SYNTHESIS OF MOLECULARLY IMPRINTED POLYMERS (MIPS) FOR THE SELECTIVE REMOVAL OF IBUPROFEN FROM BIOMEDICAL WASTEWATERS****G. Z. Kyzas\*, D. N. Bikiaris***Laboratory of Organic Chemical Technology, Department of Chemistry, Aristotle University of Thessaloniki, GR-541 24 Thessaloniki, Greece*

# SYNTHESIS OF MOLECULARLY IMPRINTED POLYMERS (MIPS) FOR THE SELECTIVE REMOVAL OF IBUPROFEN FROM BIOMEDICAL WASTEWATERS

**George Z. Kyzas\*, Dimitrios N. Bikiaris**

*Laboratory of Organic Chemical Technology, Department of Chemistry, Aristotle University of Thessaloniki, GR-541 24 Thessaloniki, Greece*

## Summary

Molecularly Imprinted Polymers (MIPs) were prepared for the selective isolation of ibuprofen (pharmaceutical compound) from aqueous matrices of biomedical wastewaters.

## Introduction

One of the most hot-topics of recent research is the reuse of some compounds existed as pollutants in environment. These compounds (molecules, ions, complexes, etc) are of high-added value and it will be ideal to selectively bind them with any environmental application and reuse them in their initial or modified form. The latter can be achieved using molecular imprinting. The whole process is based on adsorption technology, which is already one of the most successful techniques for pollutants removal. Pharmaceuticals are of scientific and public concern as newly recognized classes of environmental pollutants and are receiving considerable attention with respect to their environmental fate and toxicological properties over the last 15 years [1,2]. Ibuprofen is a nonsteroidal anti-inflammatory drug (NSAID) used for relieving pain, helping with fever and reducing inflammation. Ibuprofen has an antiplatelet effect, though it is relatively mild and somewhat short-lived compared with aspirin or prescription antiplatelet drugs. In general, ibuprofen also has a vasodilation effect.

## Synthesis of (IBU-MIP)

For the preparation of IBU-MIP, 2mmol of MAA, 10 mmol EGDMA, 1.6 mmol IBU and 0.05 g AIBN were dissolved in 50 mL of the organic solvent DMF. The functional monomer and cross-linker were determined by the ratio of 2:10. The mixture of reagents was stirred for 2 h, followed by nitrogen sparging (~5 min) to remove oxygen. After then, the flask was immediately sealed and stirring was continued at 75 °C for 12 h. The flask was then smashed and the monolithic polymers obtained, were ground in a laboratory mortar and pestle. Next, the obtained particles were washed with acetone and hot water, followed by extraction in a Soxhlet apparatus using methanol, in order to remove residuals of the monomers and template molecules. The extraction lasted for 16 h, a sum of 30 – 35 solvent cycles (each cycle lasts approximately 30 min). At the end of the 16-h period, the higher percentage of template molecules (97%) was removed from the polymer matrix, giving that for non-covalent imprinting 85 – 95% was reported to be the ideal range of the template extraction from the polymer. Non-imprinted polymers (NIPs) were prepared with the same procedure just in the absence of the template molecule.

## Results and Discussion

SEM showed that the surface of MIPs was not smooth but it had many channels and cavities.

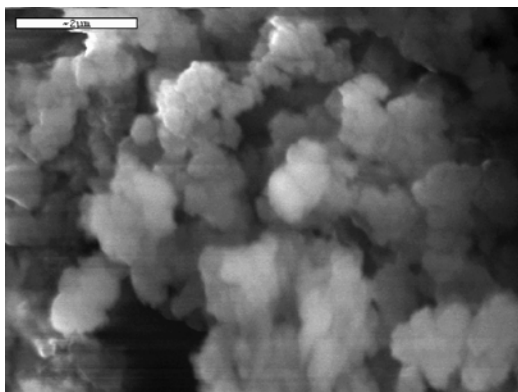


Figure 1. SEM photos of IBU-MIP adsorbed.

The experiments for the pH effect showed that the optimum value was at alkaline conditions (pH=10), while the maximum theoretical adsorption capacity was found to be 54 mg/g at 25 °C. The latter was found after fitting to the combinational isotherm model of Langmuir-Freundlich. The adsorption was reached at equilibrium slowly (~6 h) after testing the optimum adsorption contact time. The selectivity tests with other similar pharmaceutical compounds showed extremely large selectivity to IBU molecules, revealing the excellent use of this material as selective adsorbent.

## Conclusions

The synthesis of IBU-MIPs was effectively acted for the isolation (removal) of ibuprofen compound from aqueous matrices, presenting 54 mg/g maximum theoretical adsorption capacity and very high selectivity degrees.

## Acknowledgments

The support for this study was received from the State Scholarships Foundation (IKY) of Greek Ministry of Education and Religious Affairs (in the framework of the Hellenic Republic - Siemens Settlement Agreement) through the research program "IKY Fellowships of Excellence for Postgraduate Studies in Greece - Siemens Program" under the title "Advanced Molecularly Imprinted Polymers (MIPs) as materials for the selective binding and recovery of various high-added value environmental targets with application to industrial-scale adsorption columns", which is gratefully appreciated.

## References

- [1] K. Kümmerer, Antibiotics in the aquatic environment - A review - Part I, *Chemosphere*, 75 (2009) 417-434.
- [2] D. Fatta-Kassinos, S. Meric, A. Nikolaou, Pharmaceutical residues in environmental waters and wastewater: Current state of knowledge and future research, *Analytical and Bioanalytical Chemistry*, 399 (2011) 251-275.



# Synthesis of Molecularly Imprinted Polymers (MIPs) for the selective removal of Ibuprofen from biomedical wastewaters



George Z. Kyzas and Dimitrios N. Bikiaris

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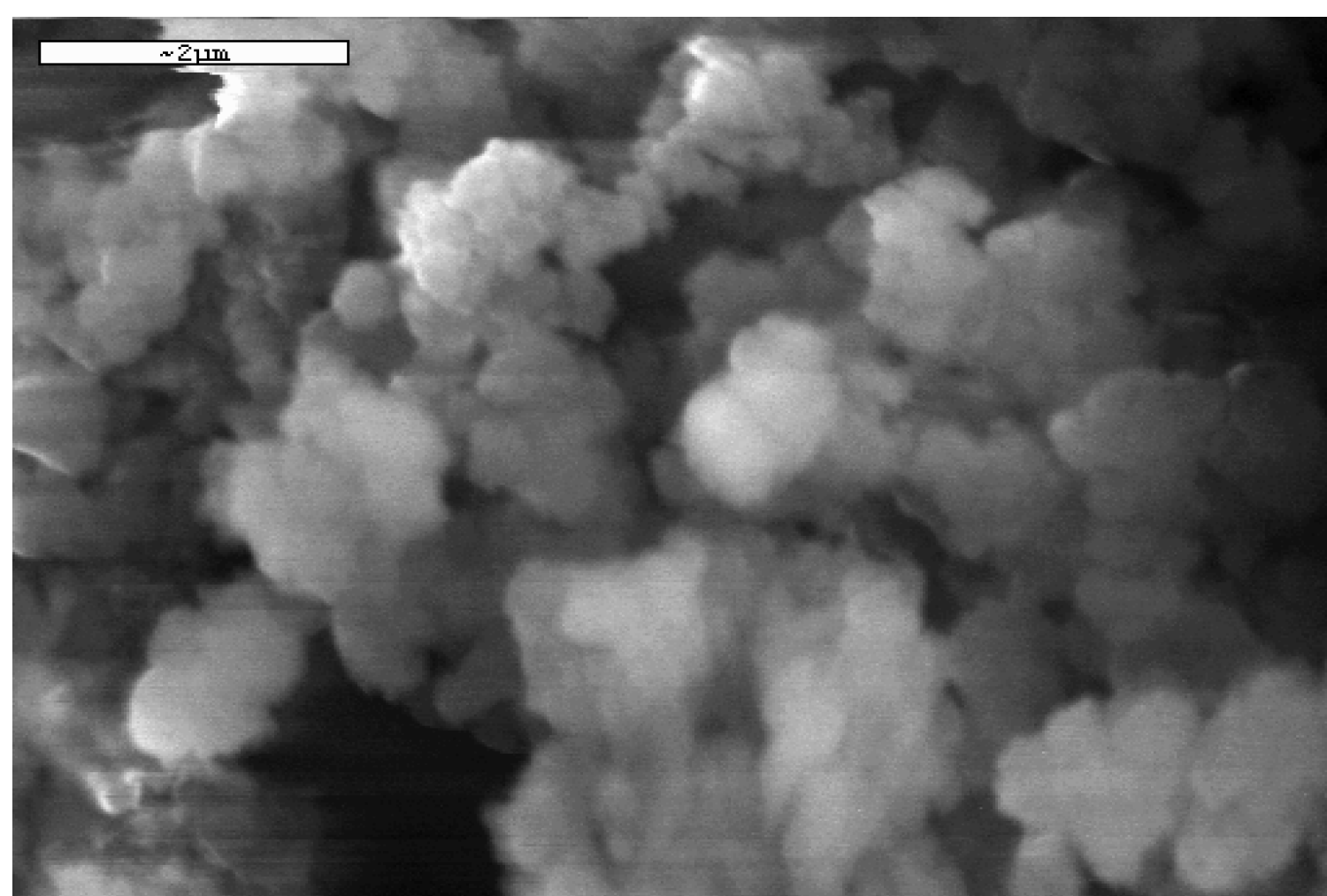
## Abstract / Aim / Novelty

One of the most hot-topics of recent research is the reuse of some compounds existed as pollutants in environment. These compounds (molecules, ions, complexes, etc) are of high-added value and it will be ideal to selectively bind them with any environmental application and reuse them in their initial or modified form. The latter can be achieved using molecular imprinting. The whole process is based on adsorption technology, which is already one of the most successful techniques for pollutants removal. Pharmaceuticals are of scientific and public concern as newly recognized classes of environmental pollutants and are receiving considerable attention with respect to their environmental fate and toxicological properties over the last 15 years. Ibuprofen is a nonsteroidal anti-inflammatory drug (NSAID) used for relieving pain, helping with fever and reducing inflammation. Ibuprofen has an antiplatelet effect, though it is relatively mild and somewhat short-lived compared with aspirin or prescription antiplatelet drugs. In general, ibuprofen also has a vasodilation effect.

## Synthesis of adsorbent

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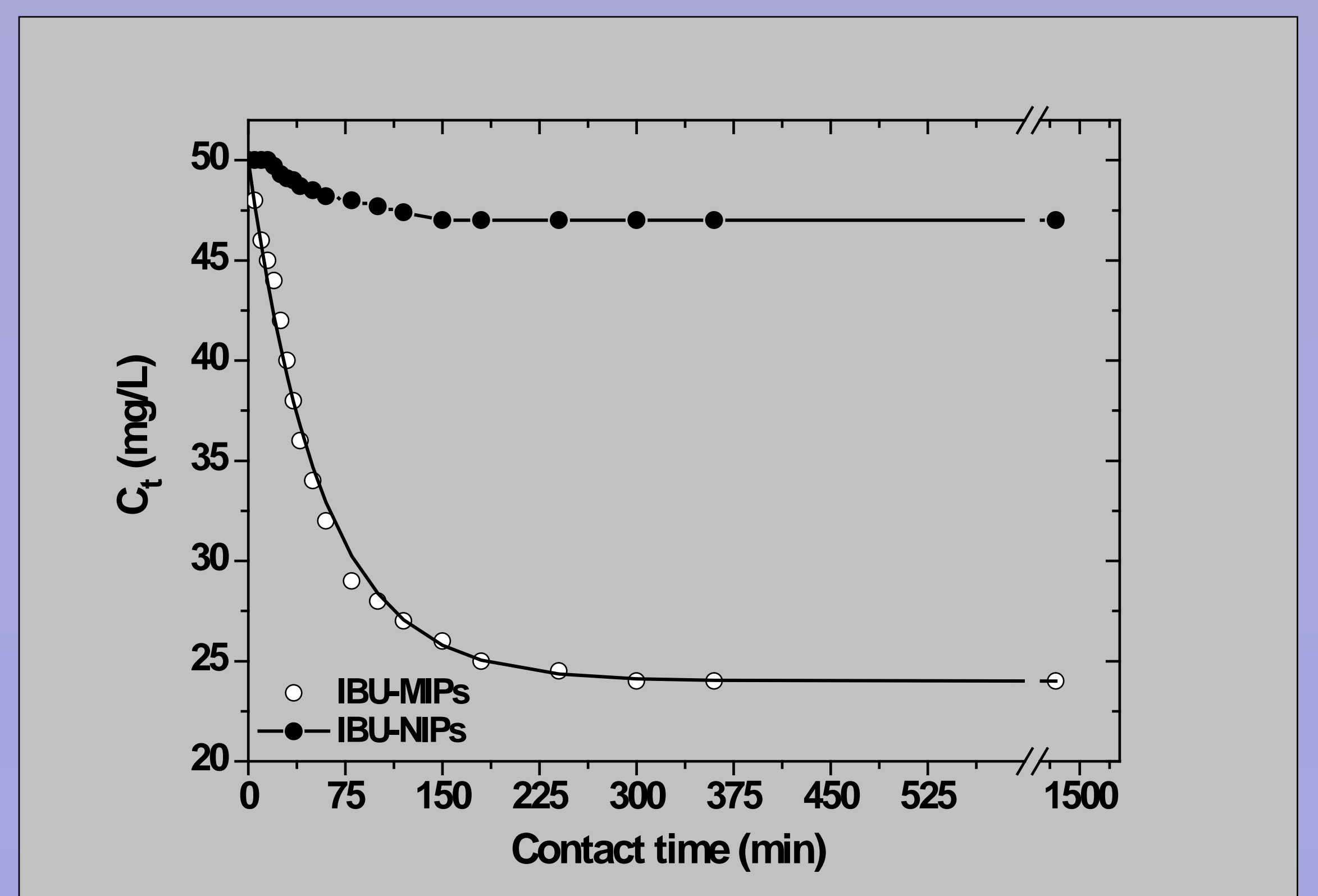
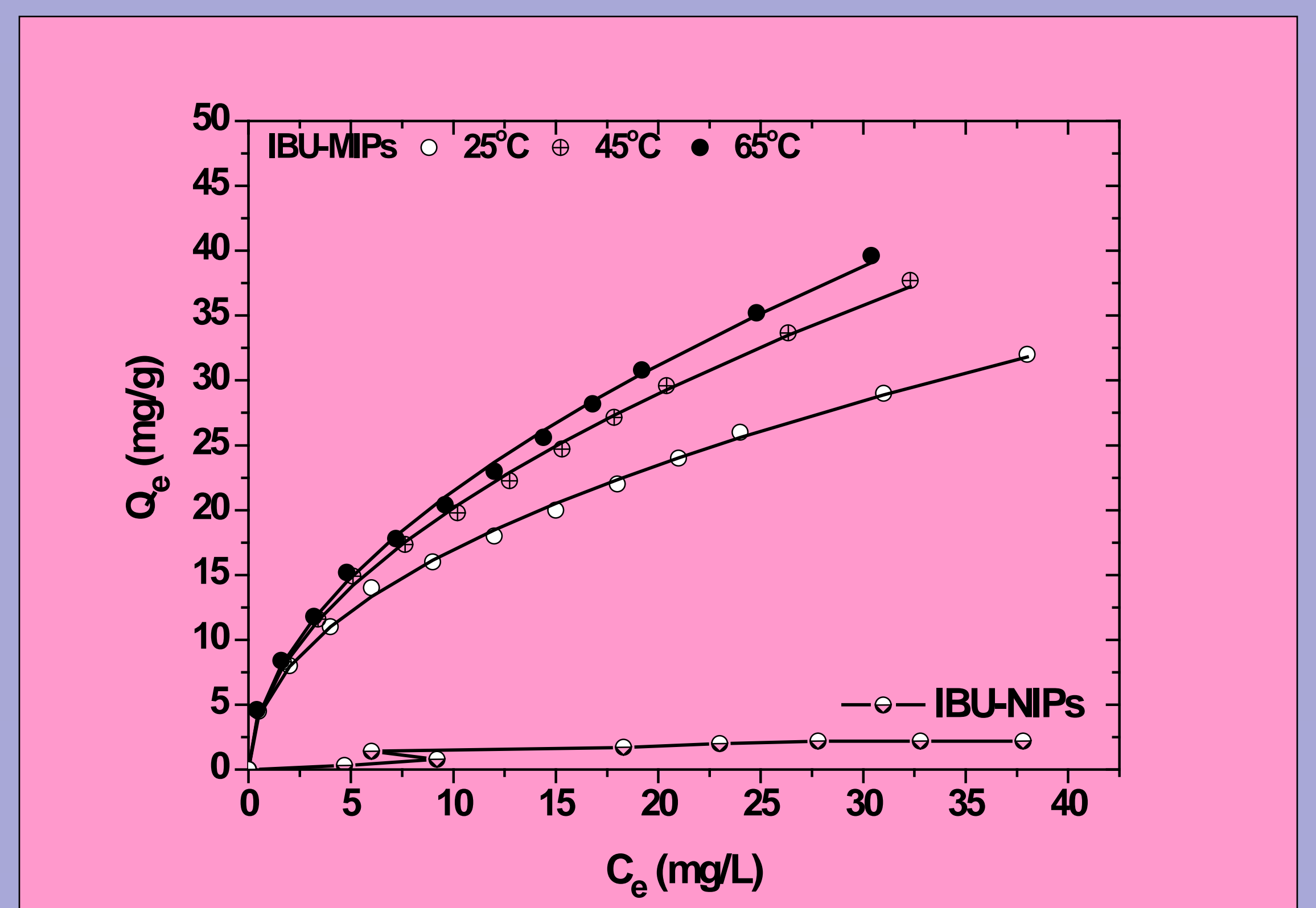
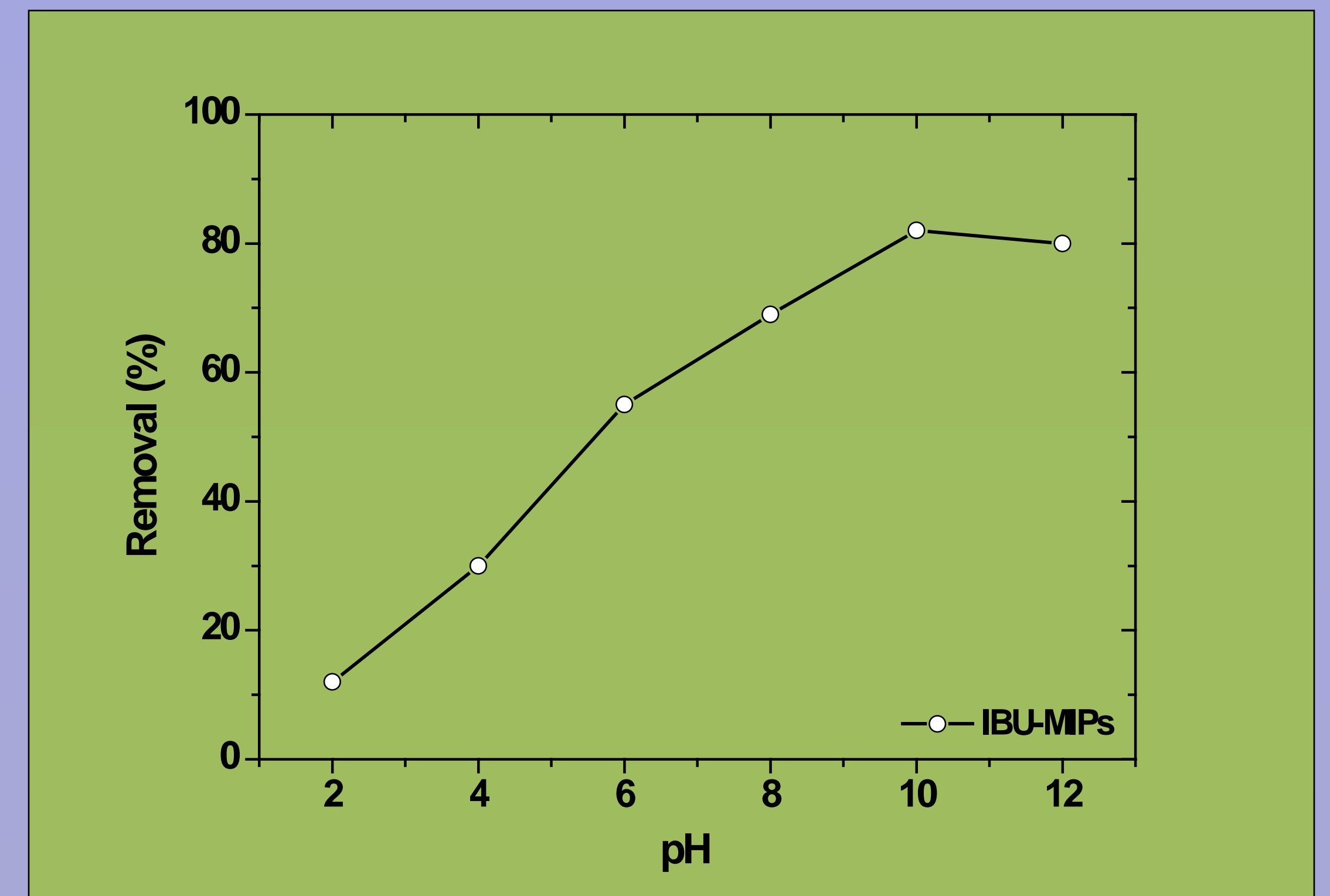
Figure 1. SEM photos of IBU-MIP adsorbed.



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## Experimental Results



## Conclusions

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This is to certify that

**KYZAS GEORGE**

attended the

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&**

**the 14th Symposium on Chemistry and Fate of Modern Pesticides**

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University of Ioannina