

Program	Program NUCLEU PN 09-13 03-02
Project title (ENG):	Advanced treatment of effluents originated from pharmaceutical industry by electrochemical processes and/or photocatalysis
Project title (RO):	Epurarea avansata a unor efluenti proveniti din industria farmaceutica prin procedee electrochimice si/sau fotocataliza
Duration	2009-2014
Team Leader	Senior Researcher Monica Ilios, Ch.E.
Summary (short description) ENG	<p>The project aimed at using electrochemical processes and photocatalysis for the advanced treatment of effluents originated from pharmaceutical industry and also those from municipal wastewater treatment plants. The pollutants taken into consideration as models belonged to the active pharmaceutical compounds with aromatic rings in their structure (refractory organic compounds) such as anti-inflammatory drugs (ibuprofen, diclofenac, naproxen and piroxicam).</p> <p>The anode materials used for the electrochemical oxidation were DSA based on noble and non-noble metal oxide films and also boron doped diamond (BDD). TiO₂ supported on zeolite was the material used for degrading by photocatalysis.</p> <p>The process was controlled by using UV-VIS absorption spectroscopy, high performance liquid chromatography (HPLC) with UV detection and gas chromatography coupled with mass spectroscopy (GC-MS).</p> <p>In order to decay the studied pollutants, the following processes were used: electrochemical oxidation, zeolite-supported TiO₂ mediated photocatalysis and photocatalytically-assisted electrochemical degradation.</p> <p>The project led to a technology for the advanced treatment of pharmaceutical effluents containing refractory organic compounds based on the best results for inducing biodegradability. By using electrochemical methods with stirring, photocatalytically-assisted electrochemical methods with stirring and combined photocatalytical-electrochemical methods with stirring, CBO5/CCO-Cr ratio increased from 0.05 to 0.2-0.4 or even higher than 0.4 in the case of pharmaceutical effluents with diclofenac.</p> <p>Electrochemical oxidation at DSA demonstrated to be efficient also for the advanced degradation of complex mixture of micro-pollutants such as nonsteroidal anti-inflammatory drugs in the effluents discharged from municipal wastewater treatment plants.</p>
Summary (short description) RO	<p>Proiectul și-a propus aplicarea proceselor electrochimice și a fotocatalizei la epurarea avansată a efluenților farmaceutici precum și a efluenților stațiilor municipale de epurare. Ca model de poluanți s-au ales compuși activi farmaceutici având în structura nucleee aromatice (compuși organici refractari), așa cum sunt antiinflamatoarele (ibuprofen, diclofenac, naproxen și piroxicam). Materialele de anod utilizate pentru oxidarea electrochimică au fost DSA cu peliculă de oxizi ai metalelor nobile și nenobile și diamantul dopat cu bor (BDD), iar pentru degradarea prin fotocataliza materialul utilizat a fost TiO₂ pe suport zeolitic.</p> <p>Controlul procesului s-a făcut cu ajutorul spectrofotometriei de absorbție UV-VIS, cromatografia de lichide de înaltă performanță (HPLC) cu</p>

	<p>detectie UV si cromatografia de gaze cuplata cu spectrometria de masa (GC-MS).</p> <p>S-au aplicat urmatoarele procese pentru degradarea poluantilor studiati: oxidarea electrochimica, fotocatalitza mediata de TiO₂ pe suport zeolitic si degradarea electrochimica asistata fotocatalitic.</p> <p>A fost elaborată tehnologia de epurare avansată a efluenților farmaceutici cu conținut de compuși organici refractari pe baza celor mai bune rezultate obținute în inducerea biodegradabilității. Prin aplicarea procedeeleor electrochimic cu agitare, electrochimic cu agitare asistat fotolitic, combinat fotocatalitic - electrochimic cu agitare, valoarea raportului CBO₅/CCO-Cr a crescut de la 0,05 la valori cuprinse între 0,2-0,4 sau chiar mai mari decât 0,4 în cazul efluentilor farmaceutici cu continut de diclofenac.</p> <p>Oxidarea electrochimica pe DSA s-a dovedit eficienta si in degradarea avnsata a amestecului complex de micropoluanti de tipul antiinflamatoarelor nesteroidiene din efluentii statiilor de epurare municipale.</p>
Dissemination of results	
PhD Thesis – Title RO, ENG	<p>Degradarea electrochimica avansata a compusilor farmaceutici de tipul antiinflamatoarelor nesteroidiene – poluanti emergenti din apa, utilizand anodi cu dimensiuni stabile</p> <p>Advanced electrochemical degradation of nonsteroidal anti-inflammatory drugs - emergent pollutants from water, using dimensionally stable anodes</p>
Full-paper ISI	<p>Manea, F., Ihos, M., Remes, A., Burtica, G., Schoonman, J., Electrochemical determination of diclofenac sodium in aqueous solution on Cu-doped zeolite-expanded graphite-epoxy electrode, <i>Electroanalysis</i>, 2010, 22(17-18), 2058-2063, ISSN: 1040-0397, WOS: WOS:000281904400019</p> <p>Ihos, M., Remes, A., Manea, F., Electrochemical determination of diclofenac in water using boron-doped diamond electrode, <i>Journal of Environmental Protection and Ecology</i>, 2012, 13(4), 2096-2103, ISSN: 1311-5065, WOS: 000313926400005</p> <p>Ihos, M., Lazau, C., Manea, F., DSA electrodes for treating pharmaceutical effluents, <i>Environmental Engineering and Management Journal</i>, 2013, 12(5), 901-905, ISSN: 1582-9596, WOS:000325283100007</p> <p>Ihos, M., Iancu, V., Petre, J., Diclofenac removal at low concentrations from wastewaters by electrochemical oxidation, <i>Revista de Chimie</i>, 2014, 65(7), 840-843, ISSN: 0034-7752, WOS:000345545600020</p> <p>Ihos, M., Manea, F., Jitaru, M., Bogatu, C., Pode, R., Diclofenac removal from aqueous solutions by electrooxidation at boron-doped diamond (BDD) electrode, <i>Environmental Engineering and Management Journal</i>, 2015, 14(6), 1339-1345, ISSN: 1582-9596, WOS:000360500200012</p> <p>Ihos, M., Lazau C., Manea F., Andres L., Pode R., Diclofenac degradation by photocatalytically-assisted electrochemical method, <i>Journal of Environmental Protection and Ecology</i>, 2016, 17(1), 307–314, ISSN: 1311-5065, WOS: 000375503300035</p>

	<p>Ihos, M., Bogatu C., Cristea I., Manea M., Pode R., Custom-made Dimensionally Stable Anodes for Diclofenac Electrochemical Degradation, <i>Revista de Chimie</i>, 2016, 67(8), 1462-1465, ISSN: 0034-7752, WOS:000384514200011</p> <p>Ihos, M., Bogatu, C., Lazau, C., Manea, F., Pode, R., Pharmaceutically active compounds degradation using doped TiO₂ functionalized zeolite photocatalyst, <i>Revista de Chimie</i>, 2018, 69(1), 34-37, ISSN: 0034-7752, WOS:000425369600008</p>
Full-paper BDI	Remes, A., Ihos, M. , Manea, F., Electrochemical Characterization of Some Electrode Materials for Pharmaceutically Active Compounds Degradation, <i>Chemical Bulletin of „Politehnica” University of Timisoara</i> , 2010 , 55(69), 2, 152- 155, ISSN: 1224-6018
Conferences (platform, poster, abstract / full-paper	<p>Manea, F., Ihos, M., Remes, A., Burtica, G., Picken, S., Schoonman, J., Electrochemical determination of diclofenac sodium in aqueous solution on Cu-doped zeolite-expanded graphite-epoxy electrode, <i>Modern Electroanalytical Methods 2009</i>, 9-13 December, 2009, Praga, Czech Republic, Book of Proceedings, s273</p> <p>Ihos, M., Remes, A., Manea, F., Electrochemical determination of diclofenac in water using boron-doped diamond electrode, <i>International Workshop “Global and Regional Environmental Protection”</i>, 26-28 November 2010, Timisoara, Romania, Book of proceedings, vol. II, 73-76, ISBN 978-606-554-210-5 platform and abstract</p> <p>Ihos, M., Remes, A., Botau, D., Manea, F., Removal of pharmaceuticals from wastewaters by electrooxidation, <i>the 17th International Symposium on Analytical and Environmental Problems</i>, 19 September 2011, Szeged, Hungary, Book of Proceedings, 335-338, ISBN: 978-963-315- 066-5 poster and full-paper</p> <p>Ihos, M., Botau, D., Andres, L. Electrochemical methods applied to pharmaceutically active compounds degradation from wastewaters, <i>International Symposium „Environment and Industry”</i>, 16-18 November 2011, Bucuresti, Book of Proceedings, vol. I, 61-66, ISSN: 1843-5831 platform and full-paper</p> <p>Ihos, M., Botau, D., Non-steroidal anti-inflammatory drugs degradation by electrochemical methods, <i>the 18th International Symposium on Analytical and Environmental Problems, with Special Emphasis on Heavy Metal Ions as Contaminants”</i>, 24 September 2012, Szeged, Hungary, Book of Proceedings, 113-116, ISBN: 978-963-306-165-7 poster and full-paper</p> <p>Ihos, M., Lazau, C., Manea, F., DSA electrodes for treating pharmaceutical effluents, International Conference “Ecoimpuls 2012 - Environmental Research and Technology“, 25-26 October 2012 - Timisoara, Romania, Book of Abstracts, 28</p>

<p>Ihos, M., Manea, F., Botau, D., Militaru, C., Lazau, C., Pode, R., DSA electrodes involvement in photocatalytically-assisted electrochemical degradation of ibuprofen, <i>the 19th International Symposium on Analytical and Environmental Problems</i>, 23 September 2013, Szeged, Hungary, Book of Proceedings, 91-94, ISBN: 978-963-315-141-9 poster and full-paper</p>
<p>Ihos, M., Iancu, V., Petre, J., Diclofenac removal at low concentrations from wastewaters by electrochemical processes, <i>International Symposium „Environment and Industry”</i>, 29-30 October 2013, Bucharest, Romania, Book of Abstracts, 52, ISSN-L: 2344-3898 platform and abstract</p>
<p>Ihos, M., Manea, F., Jitaru, M., Bogatu, C., Pode, R., Diclofenac removal from aqueous solutions by electrooxidation at BDD electrode, International Conference „Ecoimpuls 2013 - Environmental Research and Technology”, 7-8 November 2013, Timisoara, Romania, Book of Abstracts, 27 platform and abstract</p>
<p>Ihos, M., Manea, F., Pode, R., Cyclic voltammetry tool for assessing electrochemical degradation of diclofenac, <i>the 20th International Symposium on Analytical and Environmental Problems</i>, 22 September 2014, Szeged, Hungary, Book of Proceedings, 18-21, ISBN: 978-963-12-1161-0 poster and full-abstract</p>
<p>Ihos, M., Manea, F., Pode, R., Degradation of piroxicam by electrochemical oxidation at DSA electrodes, <i>the 4th International Conference „Ecology of urban areas 2014”</i>, 9-10 October 2014, Zrenjanin, Serbia, Book of abstracts, 29 and CD of Proceedings, 276-284, ISBN 978-86-7672-237-2 platform, abstract and full-paper</p>
<p>Ihos, M., Manea, F., Pop, A., Lazau, C., Pode, R., DSA electrodes for pharmaceutical wastewater treatment by advanced oxidation processes, <i>the 8th International Conference on Environmental Engineering and Management – CEEM08</i>, 9 - 12 September 2015, Iasi, Romania, Book of Abstracts, 167-168, ISSN 2457-7057, ISSN-L 2457-7049 poster and abstract</p>
<p>Ihos, M., Lazau, C., Manea, F., Andres, L., Pode, R., Diclofenac degradation by photocatalytically-assisted electrochemical method, <i>International Symposium „Environment and Industry”</i>, 29-30 October 2015, Bucharest, Romania, Book of Abstracts, 50, ISSN-L: 2344-3898 platform and abstract</p>
<p>Ihos, M., Bogatu, C., Cristea, I., Manea, F., Pode, R., Custom made dimensionally stable anodes for diclofenac electrochemical degradation, <i>International Symposium „Environment and Industry”</i>, 13-14 October 2016, Bucharest, Romania, Book of Abstracts, 171, ISSN-L 2344-3898</p>
<p>Ihos, M., Bogatu, C., Lazau, C., Manea, F., Pode, R., Pharmaceutically active compounds degradation using doped TiO₂ functionalized zeolite photocatalyst, <i>International Symposium „Environment and Industry”</i>, 28-29 September 2017, Bucharest, Romania, Book of Abstracts, 55, ISSN-L: 1843-5831</p>