Department of Chemistry

Educational and Scientific Center of Materials Science and Nanotechnology

PROJECT «Creating of new generation of sorbents for heavy metal and strontium removal from the water environment»

(Ministry of Education and Science of Ukraine (MESU)

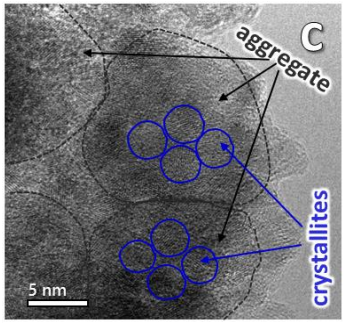
2017 – 2019

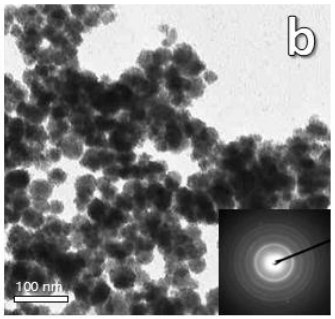
Head of Chemistry Department, Prof. Ivan F. Mironyuk
Director of center, Dr. Tetiana Tatarchuk

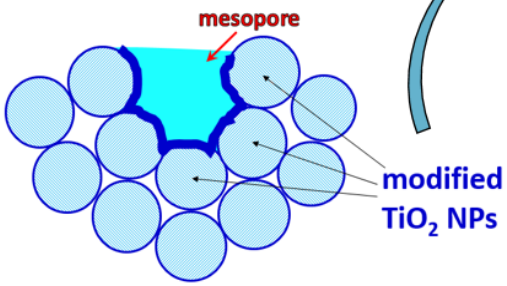
Goal: to create a new generation of titania-based sorbents for water purification from heavy metals (Ni(II), Cu(II), Zn(II), Cr(VI)) and radionuclides (Strontium).

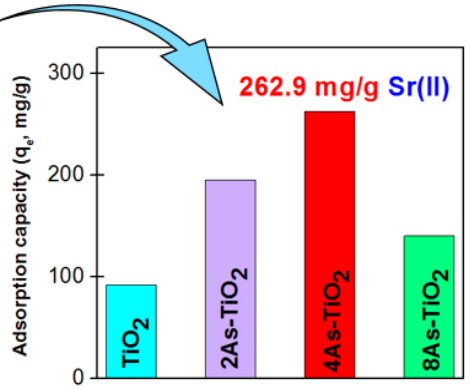
The anatase-based composite sorbents can be prepare in the powder and granular forms and can be used in the environmental technologies:

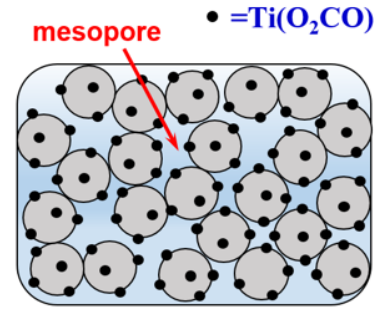
- ✓ **the technology of contaminants removal (heavy metals, dyes, phenols, etc.) from wastes and natural waters;**
- ✓ **in the sorption technologies of radioactive waste concentrating at nuclear power plants;**
- ✓ **for the purification of artesian water from strontium, uranium and transuranic elements;**
- ✓ **for reducing of water hardness.**





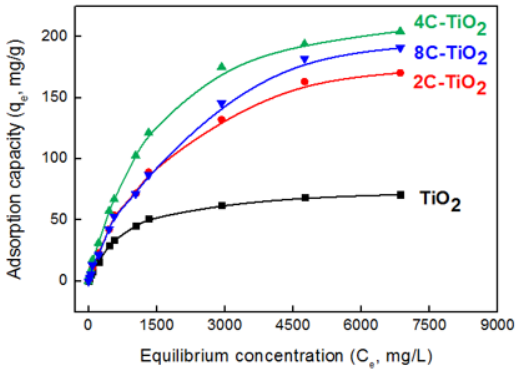






mesoporous carbonated TiO_2

+ Sr(II)



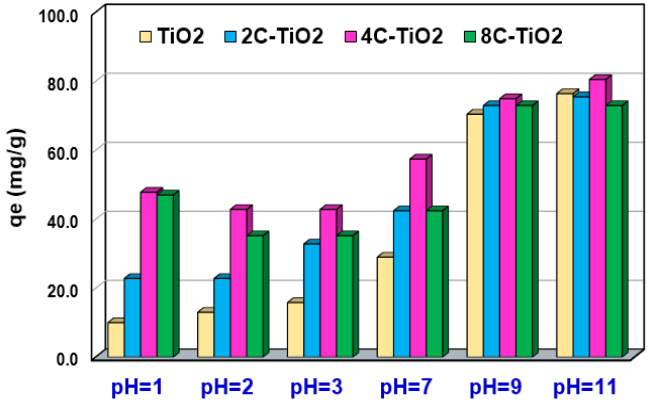


Fig. The influence of pH on Sr(II) removal by non-modified and carbonated TiO_2 samples (conditions: initial Sr(II) concentration 0.01 mol·L^{-1}; pH 7.0; T 293 K).

Publications (SCOPUS): 15 papers (total IF > 40)

3 book chapters (Springer, Wiley)

magnetocontrolled sorbents

PROJECT «Metal oxide magnetically controlled nanostructures for environmental and biomedical applications»

(Ministry of Education and Science of Ukraine (MESU)

2018 – 2020

Professor **Alex Shyichuk**
Director of center **Tetiana Tatarchuk**

Goal: to synthesize non-agglomerated nanoparticles of magnetic ferrites with different cationic composition, to study the influence of non-magnetical active ions on their structural and magnetic properties, as well as to obtain new materials that can be used in the environmental catalysis, adsorption processes, magnetic hyperthermia and magnetic resonance imaging.

Magnetic adsorbents

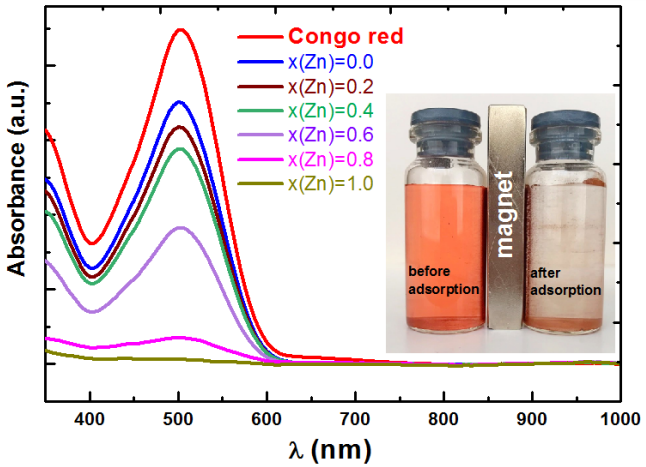


Fig. The absorption spectra of Congo Red residual concentration after adsorption onto magnetic magnesium-zinc ferrite nanoparticles. In the inset the corresponding photographs are shown: CR solution with concentration of 25 mg/L before and after adsorption onto $Mg_{0.2}Zn_{0.8}Fe_2O_4$

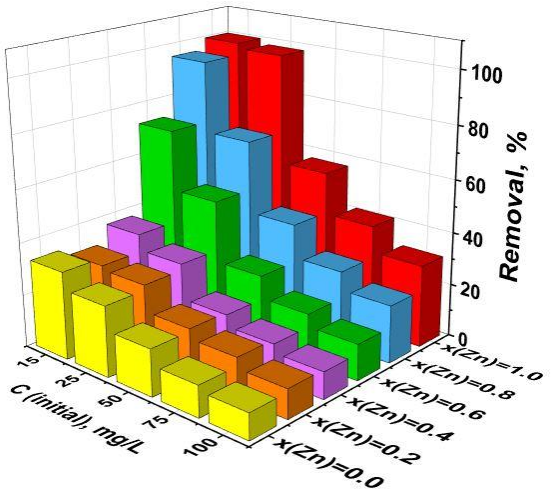
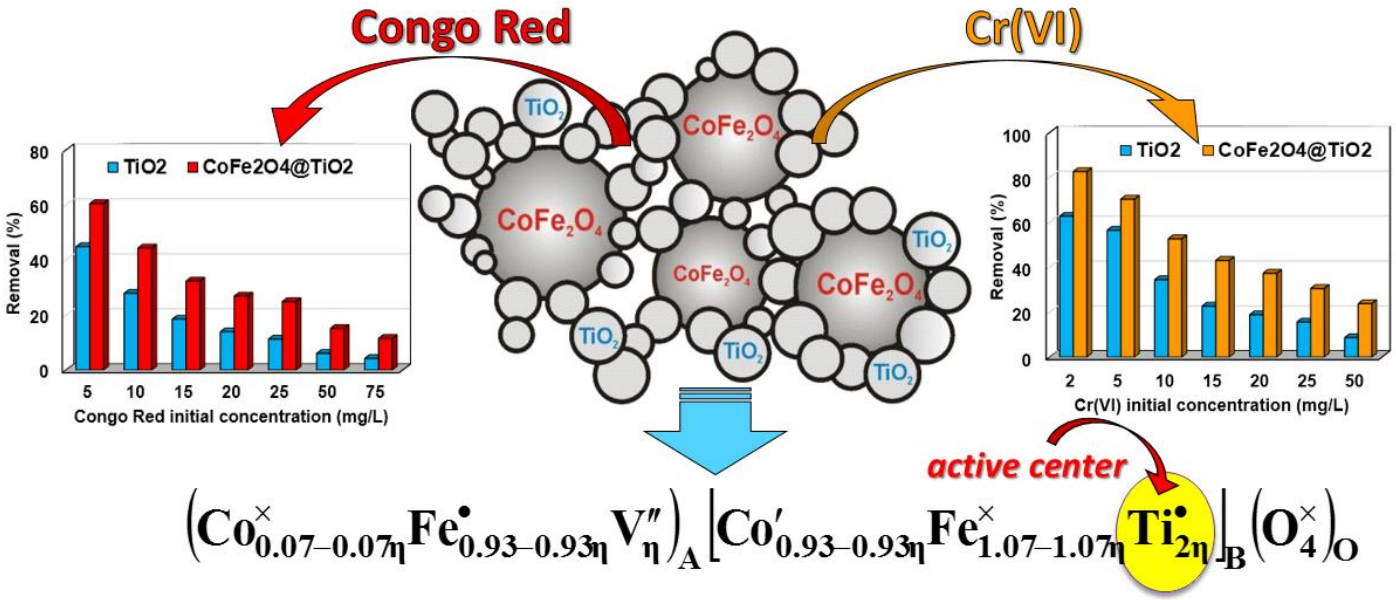
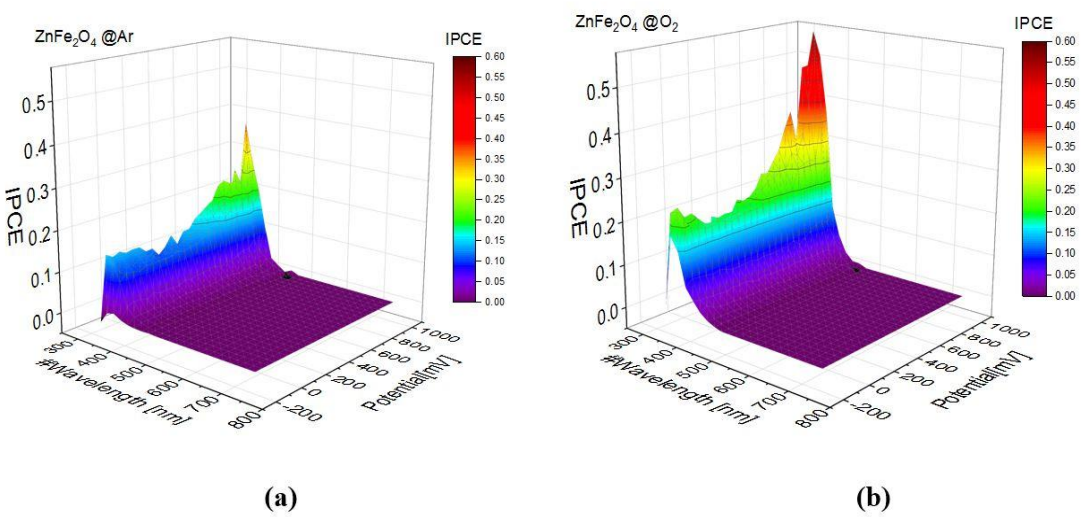


Fig. The removal efficiencies of $Mg_{1-x}Zn_xFe_2O_4$ samples for Congo Red dye.



Catalysts



(a) (b)

Fig. The examples ($ZnFe_2O_4$) of 3D plots of photocurrent *vs.* incident light wavelength and the electrode potential for oxygen free (a) and oxygen saturated (b) electrolyte.

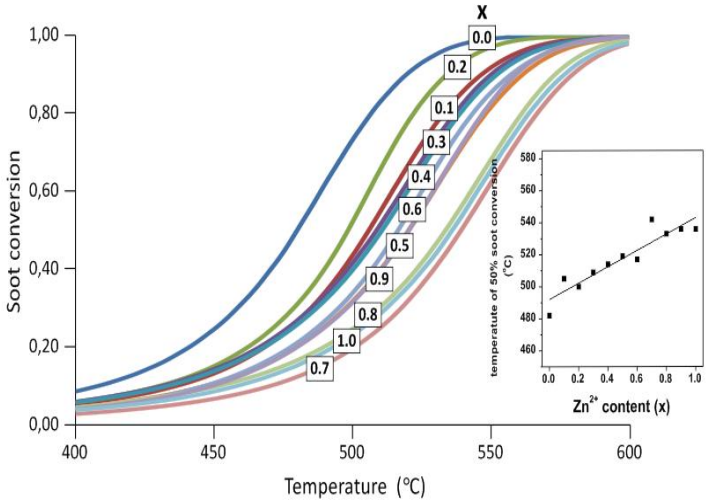


Fig. Soot conversion as a function of temperature for $Co_{1-x}Zn_xFe_2O_4$ series (Inset: soot oxidation activity represented as the temperature of 50% soot conversion as a function of zinc content).

Publications (SCOPUS): 20 papers (total IF > 50)

2 book chapters (Springer, Wiley)

PROJECT «Composite building materials based on the cement and fly ash, obtained from thermal power plants»

(contract with cement plant)

2018 – 2020

IFCEM

Head of Chemistry Department, Prof. **Ivan F. Mironyuk**
Director of center, Dr. **Tetiana Tatarchuk**

Goal: to investigate the impact of modified coal fly ash on mechanical performance of cement materials

The utilization of the coal fly ash will reduce the price of Portland cement and solve the environmental problems on the territory around the Burshtyn thermal power plant (Ukraine).

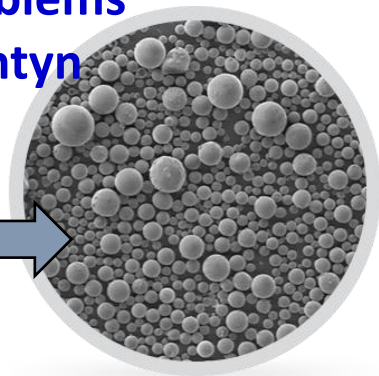


Fig. Testing machine Walter+Bai AG DB300/20 SUPER (PJSC "Ivano-Frankivskcement").

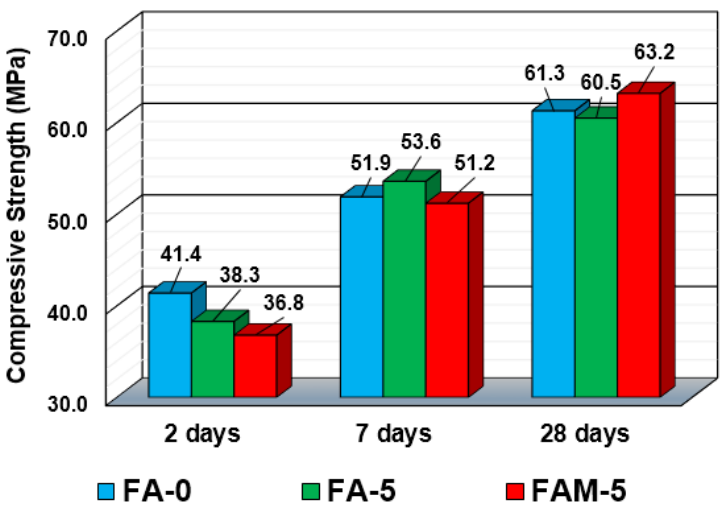


Fig. Compressive strength of cement mortars with modified FA of 0.5 % (wt.) at ages 2, 7, and 28 days.

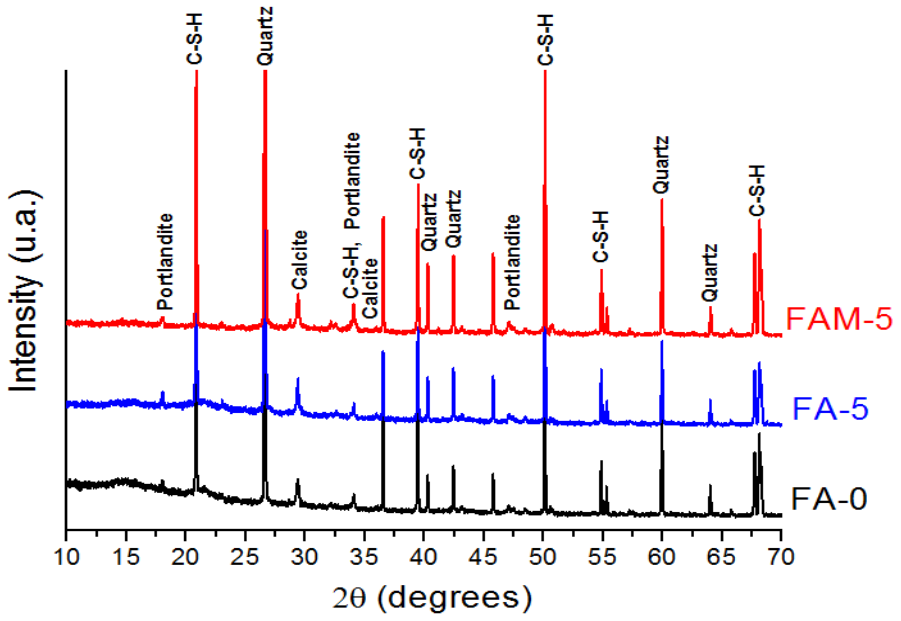


Fig. XRD patterns of cement mortars at age of 28 days.

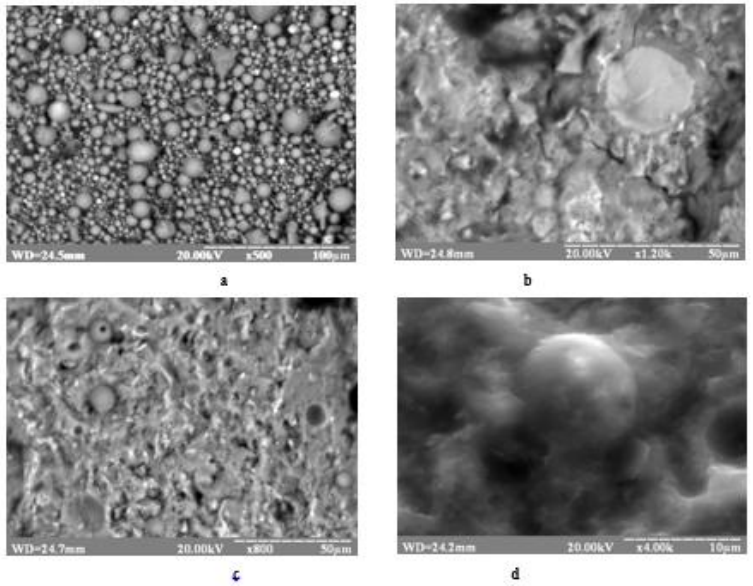
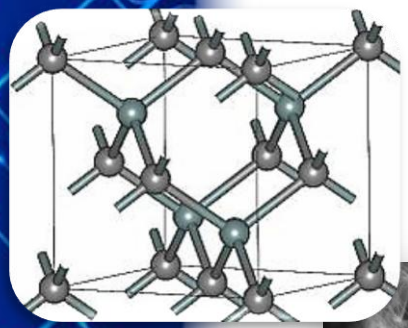


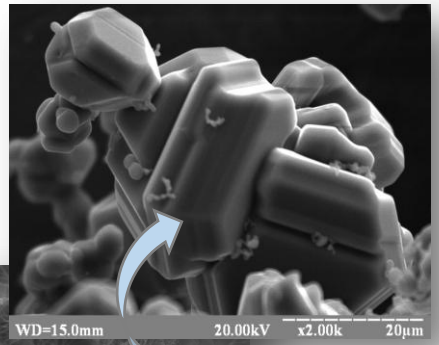
Fig. Microstructures of (a) raw fly ash and cement mortars (b) FA-0; (c) FA-5; (d) FAM-5 at age 28 days.

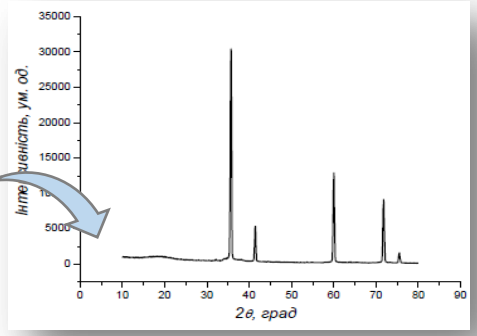
PROJECT «SYNTHESIS OF HIGH-PURE SILICON CARBIDE»

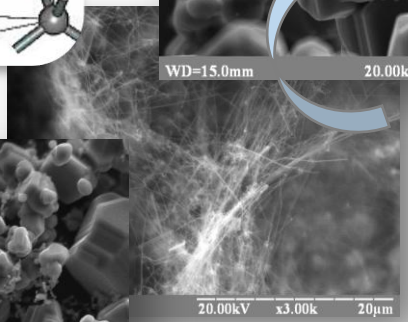
Head of Chemistry Department, Prof. **Ivan F. Mironyuk**

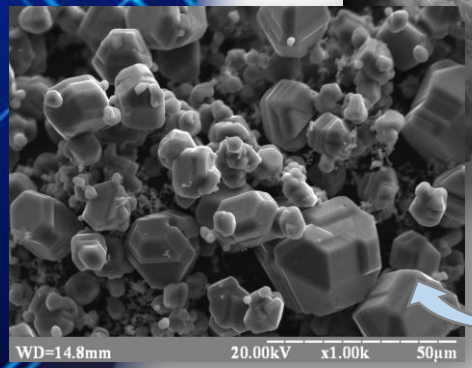
The SiC is a material for growing of single crystals, which are also used as a substrate for the manufacture of power electronic elements. A new technology for silicon carbide SiC powder producing has been developed. The content of impurities does not exceed 10^{-4} % (mass.). The crystal structure of silicon carbide is β-SiC. The monocrystalline SiC – moissanite, which is attractive for the jewelry industry, can also be obtained on the basis of this product.

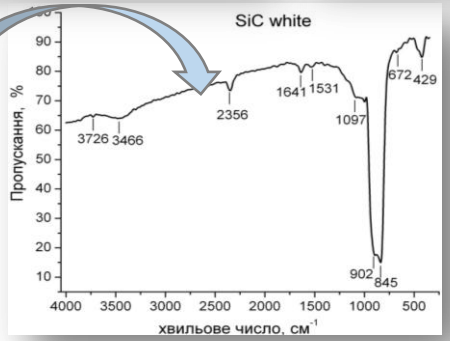










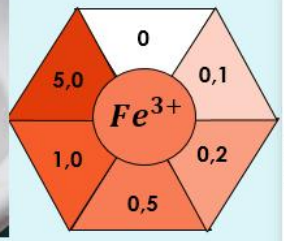


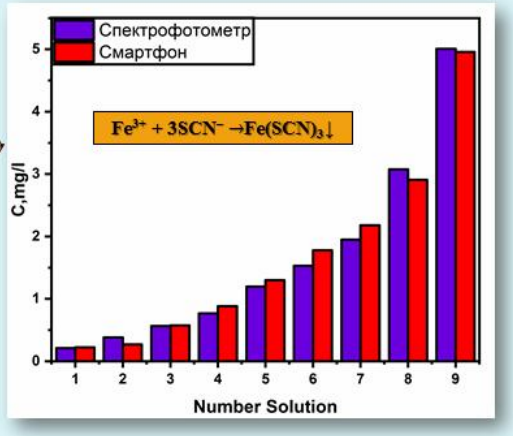
PROJECT «SMART-analysis» 2019

Professor **Alex Shyichuk**
Director of center **Tetiana Tatarchuk**
Master student **Nazariy Danyliuk**

Goal: to create a compact smart-photometer and to develop a mobile software for SMART analysis of water and food.

Смартфон vs Спектрофотометр

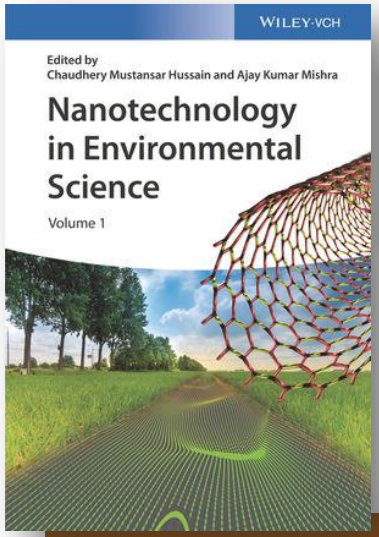




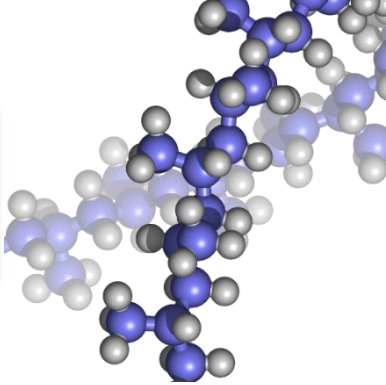
Діапазон визначення від 0,2 до 5 мг/л (похибка ±2%)

International co-operation

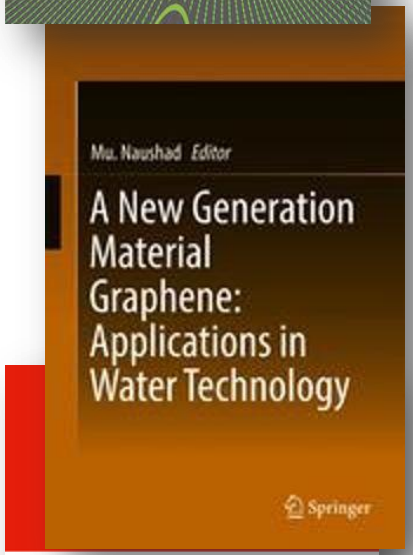
- *Jagiellonian University (POLAND)*
- *University of Bahrain (*Kingdom of BAHRAIN)
- *Devi Ahilya University (INDIA)*
- *Al Azhar University (EGYPT)*
- *King Saud University (SAUDI ARABIA)*



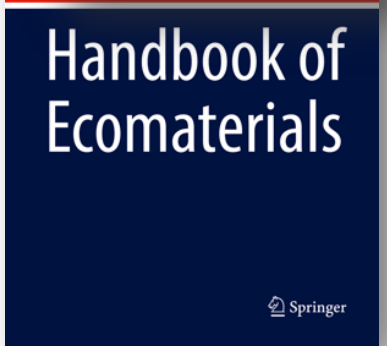
Book chapters: Springer and Wiley (SCOPUS)



Tatarchuk, T., Peter, A., Al-Najar, B., Vijaya, J. and Bououdina, M. (2018) Photocatalysis: Activity of Nanomaterials, in Nanotechnology in Environmental Science (eds C. M. Hussain and A. K. Mishra), **Wiley-VCH** Verlag GmbH & Co. KGaA, Weinheim, Germany, p.209-292, Online ISBN: 9783527808854; Print ISBN: 9783527342945



Tatarchuk T., Bououdina M., Al-Najar B., Bitra R.B. (2018) Green and Ecofriendly Materials for the Remediation of Inorganic and Organic Pollutants in Water. In: Naushad M. (eds) A New Generation Material Graphene: Applications in Water Technology. **Springer**, Cham, pp 69-110, ISBN 978-3-319-75483-3

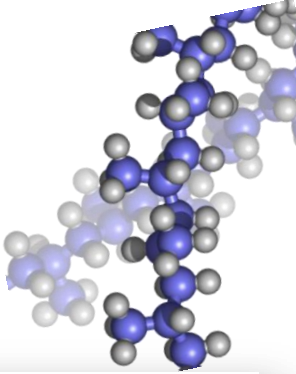


Tatarchuk T., Al-Najar B., Bououdina M., Ahmed M.A.A. (2018) Catalytic and Photocatalytic Properties of Oxide Spinels. In: Martínez L., Kharissova O., Kharisov B. (eds) Handbook of Ecomaterials. **Springer**, Cham, pp 1-50, ISBN 978-3-319-48281-1

Scientific articles

40 papers in the international journals (SCOPUS)

in 2018-2019 years




Journal of Alloys and Compounds 731 (2018) 1256–1266

Contents lists available at ScienceDirect

Journal of Alloys and Compounds

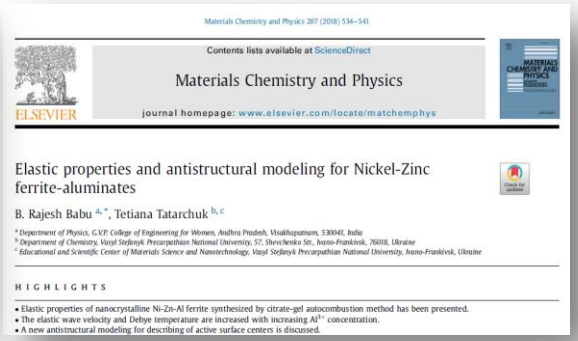
journal homepage: http://www.elsevier.com/locate/jalcom

Effect of cobalt substitution on structural, elastic, magnetic and optical properties of zinc ferrite nanoparticles

T.R. Tatarchuk [a, *], N.D. Paliychuk [a], M. Bououdina [b], B. Al-Najar [b], M. Pacia [c], W. Macyk [c], A. Shyichuk [d]

ARTICLE INFO

ABSTRACT


Materials Chemistry and Physics 207 (2018) 534–541

Contents lists available at ScienceDirect

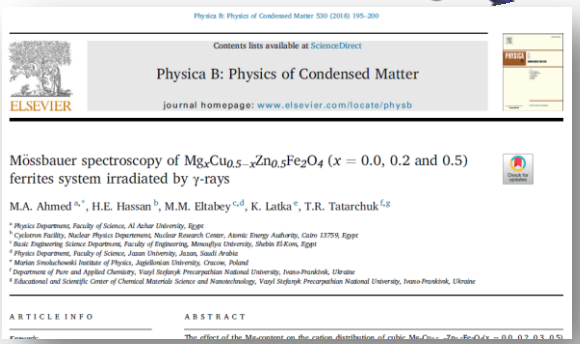
Materials Chemistry and Physics

journal homepage: www.elsevier.com/locate/matchemphys

Elastic properties and antistructural modeling for Nickel-Zinc ferrite-aluminates

B. Rajesh Babu [a, *], Tetiana Tatarchuk [b, c]

HIGHLIGHTS


Physica B: Physics of Condensed Matter 530 (2018) 195–200

Contents lists available at ScienceDirect

Physica B: Physics of Condensed Matter

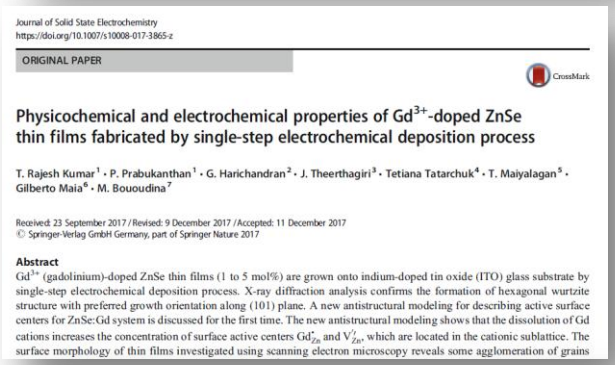
journal homepage: www.elsevier.com/locate/physb

Mössbauer spectroscopy of $Mg_xCu_{0.5-x}Zn_{0.5}Fe_2O_4$ ($x = 0.0$, 0.2 and 0.5) ferrites system irradiated by γ-rays

M.A. Ahmed [a, *], H.E. Hassan [b], M.M. Eltabey [c, d], K. Latka [e], T.R. Tatarchuk [f, g]

ARTICLE INFO

ABSTRACT


Journal of Solid State Electrochemistry
https://doi.org/10.1007/s10008-017-3865-z

ORIGINAL PAPER

Physicochemical and electrochemical properties of Gd^{3+}-doped ZnSe thin films fabricated by single-step electrochemical deposition process

T. Rajesh Kumar [1] · P. Prabukanthan [1] · G. Harichandran [2] · J. Theerthagiri [3] · Tetiana Tatarchuk [4] · T. Maiyalagan [5] · Gilberto Maia [6] · M. Bououdina [7]

Received: 23 September 2017 / Revised: 9 December 2017 / Accepted: 11 December 2017
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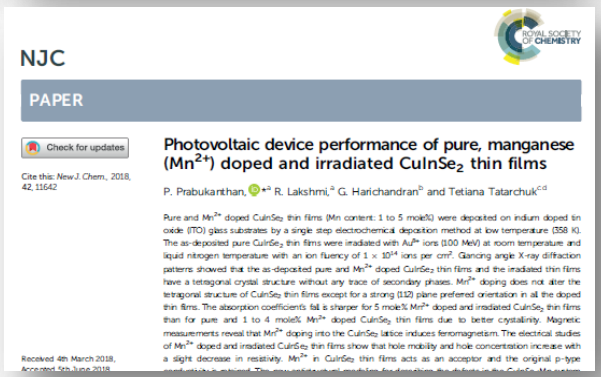
Abstract


NJC

PAPER

Photovoltaic device performance of pure, manganese (Mn^{2+}) doped and irradiated $CuInSe_2$ thin films

P. Prabukanthan, R. Lakshmi, G. Harichandran and Tetiana Tatarchuk

Cite this: New J. Chem., 2018, 42, 11642

Received 4th March 2018,


Journal of Molecular Liquids 285 (2019) 742–753

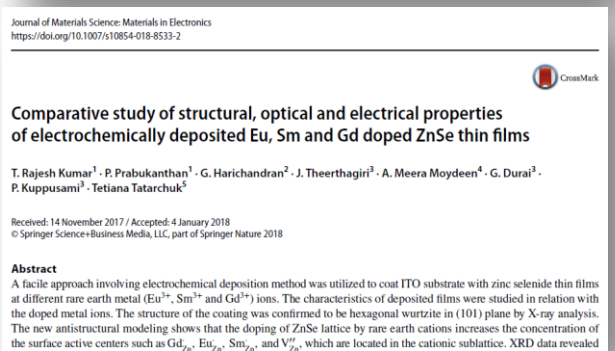
Contents lists available at ScienceDirect

Journal of Molecular Liquids

journal homepage: www.elsevier.com/locate/molliq

Highly efficient adsorption of strontium ions by carbonated mesoporous TiO_2

Ivan Mironyuk [a], Tetiana Tatarchuk [a,b,*], Mu. Naushad [c], Hanna Vasylyeva [d], Igor Mykytyn [a]


Journal of Materials Science: Materials in Electronics
https://doi.org/10.1007/s10854-018-8533-2

Comparative study of structural, optical and electrical properties of electrochemically deposited Eu, Sm and Gd doped ZnSe thin films

T. Rajesh Kumar [1] · P. Prabukanthan [1] · G. Harichandran [2] · J. Theerthagiri [3] · A. Meera Moydeen [4] · G. Durai [3] · P. Kuppusami [3] · Tetiana Tatarchuk [5]

Received: 14 November 2017 / Accepted: 4 January 2018
© Springer Science+Business Media, LLC, part of Springer Nature 2018

Abstract


International Conference on Nanotechnology and Nanomaterials

NANO 2017: Nanochemistry, Biotechnology, Nanomaterials, and Their Applications pp 357-375 | Cite as

Ni Addition Induced Changes in Structural, Magnetic, and Cationic Distribution of $Zn_{0.75-x}Ni_xMg_{0.15}Cu_{0.1}Fe_2O_4$ Nano-ferrite

Authors

Authors and affiliations

Manvi Satalkar, Shashank Narayan Kane, Tetiana Tatarchuk, João Pedro Araújo

Conference paper

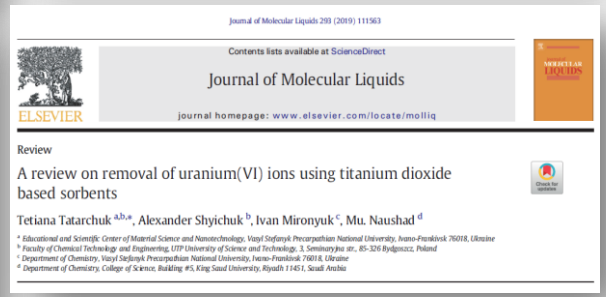
First Online: 27 June 2018

2 Citations 203 Downloads

Part of the Springer Proceedings in Physics book series (SPPHY, volume 214)

Abstract

Ni added $Zn_{0.75-x}Ni_xMg_{0.15}Cu_{0.1}Fe_2O_4$ (with $x = 0.00–0.75$) nanoparticles with Scherrer's grain diameter (D) < 56.73 nm were prepared via sol-gel auto-combustion technique. The


Journal of Molecular Liquids 293 (2019) 111563

Contents lists available at ScienceDirect

Journal of Molecular Liquids

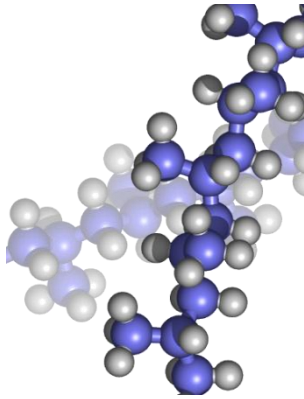
journal homepage: www.elsevier.com/locate/molliq

Review

A review on removal of uranium(VI) ions using titanium dioxide based sorbents

Tetiana Tatarchuk [a,b,*], Alexander Shyichuk [b], Ivan Mironyuk [c], Mu. Naushad [d]

Scientific articles



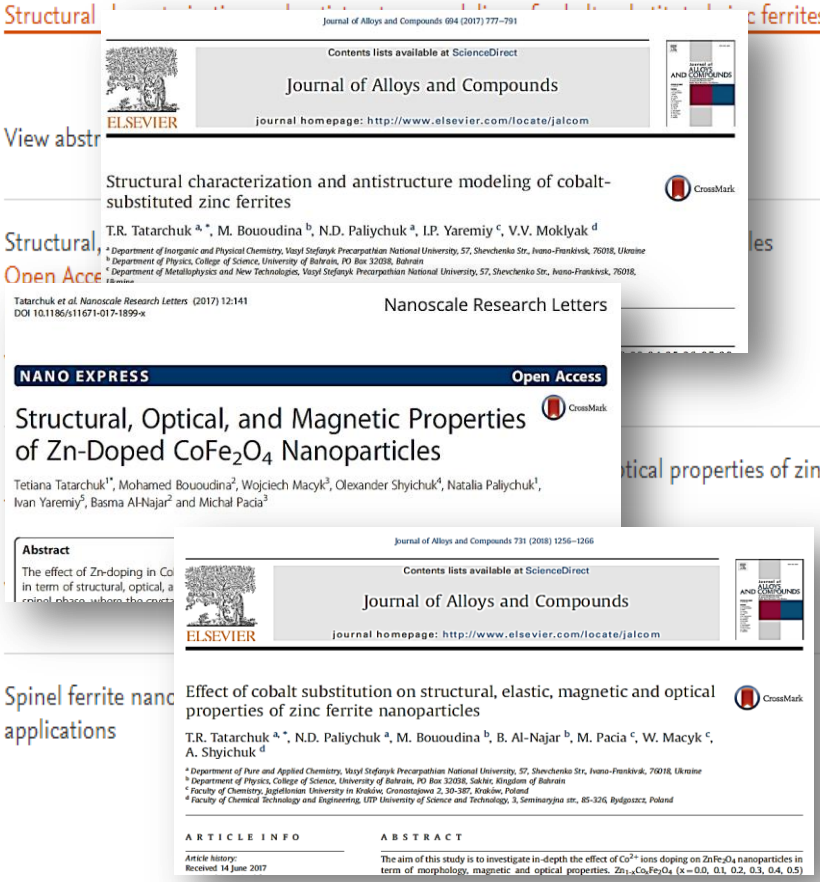
More than 500 citations in SCOPUS for 2018-2019

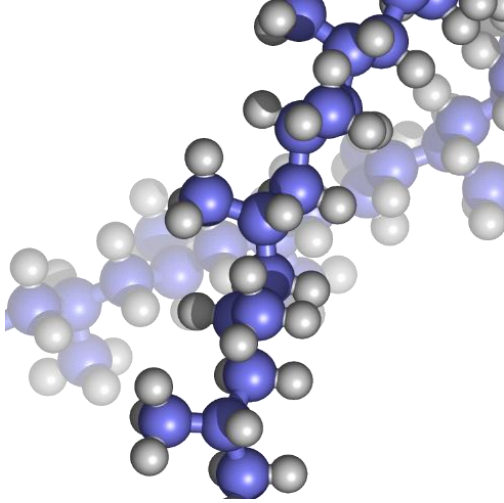
Document title	Authors	Year	Source	Cited by
Structural … ferrites	Tatarchuk, T.R., Bououdina, M., Paliychuk, N.D., Yaremiy, I.P., Moklyak, V.V.	2017	Journal of Alloys and Compounds 694, pp. 777-791	60
Structural, … Open Acce…	Tatarchuk, T., Bououdina, M., Macyk, W., (...), Al-Najar, B., Pacia, M.	2017	Nanoscale Research Letters 12(1),141	51
… tical properties of zinc	Tatarchuk, T.R., Paliychuk, N.D., Bououdina, M., (...), Macyk, W., Shyichuk, A.	2018	Journal of Alloys and Compounds 731, pp. 1256-1266	43
Spinel ferrite nanc… applications	Tatarchuk, T., Bououdina, M., Judith Vijaya, J., John Kennedy, L.	2017	Springer Proceedings in Physics 195, pp. 305-325	22

60 citations

51 citations

43 citations





Thank you for your attention !

Doc.Sergiy Kurta prof.essor Chemistry Department of the Precarpathian National University, Ivano-Frankivsk, Ukraine

Ecological, resource-saving technologies of the synthesis of 1,2-dichloroethane and vinyl chloride with utilization of chlororganic wastes

Based on the increase in vinyl chloride, 1,2-dichloroethane and PVC production in Ukraine and around the world, the amount of highly toxic organochlorine waste that is incinerated has increased to 5-10%. Emissions from the combustion of organochlorine wastes are enviro-nmentally hazardous due to the formation of hydrogen chloride, chlorine, and dioxins during the combustion process. We propose to improve all 5 stages of industrial vinyl chloride syn-thesis technology and to reduce the amount of organochlorine wastes that are incinerated 10 times by recycling them into monomers and polymers for industrial reuse. The projected economic impact from the savings of raw materials - ethylene, chlorine, gas, which will not be incinerated with organochlorine waste, can amount to about $ 20 million per year at one Karpatnaftochim plant in Kalush Ukraine.

The name of the organochlorine components waste, Karpatnaftokhim, Kalush	Contents % mass.	Class dangers	Limit admissible. conc. mg / m3
1.1. Vinyl chloride	0,0003	1	1
2.2. Allyl chloride	0,0039	1	0,3
3.3.Trans-1,2-dichloroethylene	0,0009	2	20
4.4. Carbon tetrachloride	0,0215	2	15
5.5.Benzene	0,01	2	20
6.6. Chloroform	0,0134	2	10
7.7.1,1,2-trichloroethylene	0,019	2	10
8.8.1,2-DHE	16,4	2	10
9.9. Perchlorethylene	0,418	2	20
10.10.1,1,2-trichloroethane	36,61	2	5
11.11.1,1,2,2-tetrachloroethane	2,034	1	0,5
12.12.Ethylene chloride (ECG	0,444	2	10
13.14. Their (not identified by VOCs)	43,865	1	0,001
14.15.1,2,3,4,6,7,8,9-octachloro dioxin	0,001		

CHEMICAL REACTIONS

Recycling and disposal organochlorine waste production

1. Organochlorine chloridevідходів

$$CH_2 = CHCl + Cl_2 \rightarrow CH_2Cl - CHCl_2$$

2. Alkaline dehydrochlorination of waste

$$2CH2Cl - CHCl2 + Ca(OH)2 \rightarrow 2CH2 = CCl2 + CaCl2 + 2H2O$$

3. Polycondensation of organochlorine and sulfide-containing wastes

$$Cl - CH_2 - CH_2 - Cl + NaS_4Na \xrightarrow{80-90^0C} Cl - CH_2 - CH_2 - S_4 - Na + NaCl$$

Results of recycling of organochlorine wastes processing: 1. Reduction of quantity and composition of emissions at incineration 10 times less of organochlorine wastes at factories for vinyl chloride production.

2. Reduction of toxicity of liquid effluents from the production of ethylene-propylene at petrochemical enterprises.

3. Significant savings in hydrocarbons, ethylene, chlorine and energy, which are becoming more expensive.

4. Improvement of technology for catalytic synthesis of vinyl chloride and methods of utilization and recycling of organochlorine and sulfide wastes.

5. The projected economic effect only on the savings of raw materials - ethylene, chlorine, natural gas, which are now incinerated in organochlorine and sulfur-containing wastes, is about $ 20 million a year.

6. Improvement of the ecological situation in the regions of Ukraine and abroad, where organochlorine waste is burned, and the reduction of carbon monoxide and carbon dioxide, dioxins, hydrogen chloride and organochlorine compounds, which cause destruction of the Earth's ozone.

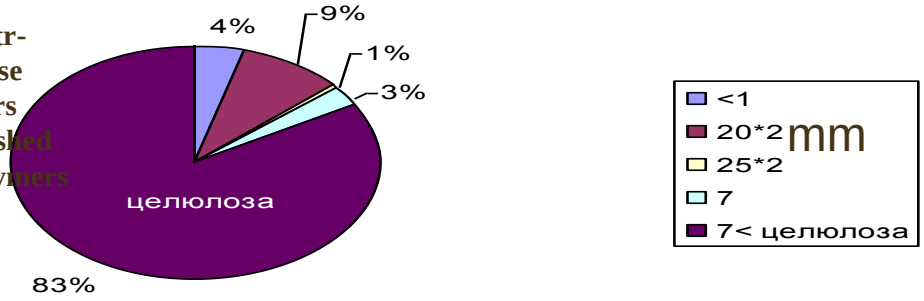
Chemistry Department VASYL STEFANYK PRECARPATHIAN NATIONAL UNIVERSITY
Sergiy Kurta - doctor of technical sciences, professor (+380509685163, kca2014@ukr.net,

Separation, utilization and recycling of waste paper containing polymers

Developed industrial technology and equipment for grinding, separation, utilization and recycling of 95% of paper waste, including wallpaper with polymer coating and packaging waste type TETRAPAK. The technology of separation and processing of paper waste with a polymer coating, includes the first stage of grinding paper waste with a polymer coating on a crusher of the disk-type. In the second stage of grinding was carried out using a drum crusher, with the separation of the cellulose fiber base (paper) from the polymer coating. In the third stage, the separation of 2 fractions - polymeric coating and cellulose fibrous base - paper, in the air stream using a specially designed separator, cyclone and fabric filter.

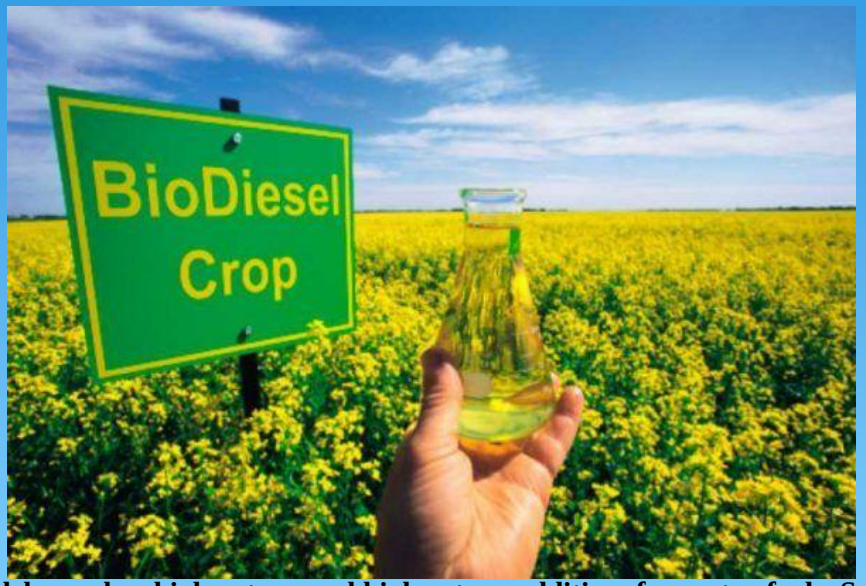
As a result of this process, 50-95% of pure cellulose and 50-5% of polymeric waste can be obtained from paper-coated paper waste. In this case, cellulose can be used to re-obtain technical paper, packaging cardboard and flizelin. The obtained secondary cellulose can be used as heat-insulating material, structural filler for the production of asbestos-free slate, for the production of fuel briquettes and pallets, construction and polymer composite materials

Fig 1. Volumetric distribution (%) of cellulose particles and polymers from industrially crushed waste paper with polymers on a universal three-stage crusher in size



CHEMISTRY DEPARTMENT VASYL STEFANYK PRECARPATHIAN NATIONAL UNIVERSITY
Sergiy Kurta - doctor of technical sciences, professor (+380509685163, kca2014@ukr.net,
Victoria Ribun-

IMPROVEMENT OF TECHNOLOGY SYNTHESIS OF BIODIESEL ON THE BASIS OF ABSOLUTE BIOETHANOL



Motor fuel combustion activators (alcohols, ethers and fatty esters) are widely used as high-octane and high-cetane additives for motor fuels. Such additives as well as bioethanol and biodiesel are produced from natural raw materials. Oxygen-containing compounds have anti-knock, oxygen-generating, washing and other beneficial properties. Their application is more environmentally friendly, because it reduces the mono- and carbon dioxide emission, the formation of solid hydrocarbons, soot and reduces the motor fuel consumption. Motor fuel combustion application in chemotology can reduce the distribution non-uniformity of gasoline detonation stability by fractions, the tendency to carbonization of fuel and significantly improve the operation and efficiency of the engine. These additives have high octane or cetane number, complete mixing, low volatility, minimal soot formation and reduced photochemical activity. Their strategic importance in chemmotology is constantly increasing, since they are obtained from natural materials - corn and vegetable oils and are renewable energy sources.

The aim of the work is the improvement of diesel and gasoline complex dewaxing technology with simultaneous octane and cetane number elevation, development and introduction of effective motor fuel combustion activators based on the improvement of bioethanol dehydratation technology and the interesterification of natural vegetable oils with increasing of biodiesel yield. Bioethanol dehydration technologies (up to 99.9%) have been improved and simplified. A new technology for the interesterification of natural vegetable oils by absolute ethanol with an increase in the biodiesel yield by 10-15% is proposed.

Chemistry Department, Vasyl Stefanyk Precarpathian National University Ivano-Frankivsk, Ukraine, Doc. Sergiy Kurta, Nadiya Boyko , Marta Tsap:(e-mail kca2014@ukr.net;tel+380509685163)

Chewing gum based on natural honey, wax and bee-glue for the prevention and treatment of periodontal diseases

Periodontal disease - it's a oral cavity, in which the periodontal begins to break down (the fabric that is responsible for fixing the teeth) and even healthy teeth swing and fall out of the gum. According to the WHO data, which is based on the discovery of 53 countries (incl. Ukraine), the highest level of diseases (65-98%) of periodontal tissue (gingivitis, periodontitis and periodontal disease) occurs in the age of 35-44 years. In 15-19 years 80% of children in the Earth are diagnosed with gingivitis. Generalized periodontitis and paradoxosis in adulthood (45-85 years) are found in 90-95% of patients with periodontal tissuesю

We offer Chewing gum on the basis of caramelized honey, wax and beeglue for the prophylaxis and treatment of periodontal disease and periodontal disease and other dental diseases is made in the form of sweets, gum for prophylaxis and protection of gums and teeth from various dental diseases, microbiological and bacterial type. The result is achieved by introducing into the composition of chewing gum specially prepared natural, caramelized beer honey, wax, propolis and other products of beekeeping. The use of chewing gum for everyday use (chewing) provides for the prevention, protection and treatment of various dental diseases, especially periodontal disease, including for children.

Chemistry Department VASYL STEFANYK PRECARPATHIAN NATIONAL UNIVERSITY
Sergiy Kurta - doctor of technical sciences, professor (+380509685163, kca2014@ukr.net,
Struminska Olena

Biopolymer compositions for the agrochemical resource-saving technology pre-processing seed of the agricultural crops with a minimum of fertilizers used

The system of preparatory farm work provides high effect preplant seed treatment by biopolymer film-forming compositions containing polymer water solution, fertilizers, minerals and other biologically active substances. These techniques carry significant impact on the behavior of the seed at sowing, growth, their productivity in different agro-ecological conditions, so great practical importance attaches special methods to assess their effectiveness, allowing selection of new grain crop. Currently, grain handling such substances carried aqueous solutions of film creators in the composition of crop protection products based on synthetic or synthetic water-soluble polymers. We offer by using only naturally occurring biopolymers in aqueous film forming composition compositions with mineral fertilizers,cavitationaly treated water, micronutrients and specially prepared water cavitation electromagnetic achieved .

1. Decontamination of seeds from pathogens of plants; 2. Protection of plants and germs of mold and fungi during their germination;
3. Reducing the negative impact of mechanical injury to the seeds ;. 4. Preventing destruction of grain pests in the field;
5. Promote plant growth in the initial period of their development; 6. Partial increase crop yields.
7. Selectivity seeds of a new crop.

Implementation of this project will allow to solve the following problems:

1) Fully provide the population of Ukraine, and other countries.inexpensive, environmentally friendly non genetically modified agricultural and food products;
2) It is essential to ten times (2-5 time) to reduce the needs of agriculture in mineral fertilizers and micronutrients for all kinds of plants;
3) To a large extent (2-5 times) to reduce pollution of the Earth fertile soil fertilizers and micronutrients to reduce the burden on the environment and especially on agricultural land and reduce pollution of groundwater and, in turn, lakes rivers and seas;
4) Several times to reduce the dependence of world chemical fertilizers and micronutrients Ukraine, and other countries.supply shortage of raw materials for their synthesis, gas and petroleum deficit which is growing all the time;
5) Solve some social problems of Ukrainian and other farming villages, primarily to reduce unemployment and improve employment in rural areas.

Photo Rice varieties "August" Botanical Garden, Ivano-Frankivsk Ukraine