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Институт Техничких наука САНУ
Кнез Михаилова 35/IV
Београд

Предмет: Захтев за покретање поступка за реизбор у звање мр Ане Станковић, истраживача сарадника у звање истраживач сарадник

НАУЧНОМ ВЕЋУ ИНСТИТУТА ТЕХНИЧКИХ НАУКА САНУ

Молим Вас да, у складу са Правилником о поступку и начину вредновања, и квантитативном исказивању научно-истраживачких резултата истраживача (Сл. Гласник РС, бр. 38/08), и Правилником о стицању звања истраживач сарадник, Научно веће Института техничких наука САНУ покрене поступак за реизбор у звање истраживач сарадник.

За чланове комисије за припрему извештаја Научном већу предлажем:

- др Смиљу Марковић, вишег научног сарадника Института техничких наука САНУ
- др Магдалену Стевановић, вишег научног сарадника Института техничких наука САНУ
- др Драгану Југовић, научног сарадника Института техничких наука САНУ

У прилогу достављам:
1. Биографију
2. Библиографију
3. Уверење о завршеним дипломским студијама
4. Уверење о одбрањеној магистарској тези
5. Одлука о избору у звање истраживач сарадник из 2010. године
6. Доказ о објављеним радовима после избора у звање 2010. године

У Београду,
22.05.2013.

Подносилац захтева:

мр Ана Стакновић, дипл. физикохемичар
Истраживач сарадник ИТН САНУ

Биографија мр Ана Станковић

Ана Станковић рођена је 13.08.1979. године у Крушевцу. Факултет за физичку хемију Универзитета у Београду уписала је школске 1998/99. године, а дипломирала је 2005. године одбранивши дипломски рад под називом „Примена глобалне оптимизације у макромолекулској кристалографији" и стекла звање дипломираног физикохемичара.

Последипломске студије уписала је на Факултету за фитзичку хемију школске 2005/06. године. У новембру 2009. године на истом факултету одбранила је магистарску тезу под називом „Утицај параметара процесирања на ток механохемијске синтезе и спречавање појаве агломерације синтетисаних нано-структурних прахова" чиме је стекла звање магистра физичкохемијских наука.

У Институту техничких наука САНУ запослена је од 14.07.2005. године. Као истраживач сарадник ангажована је на пројекту интегралних и интердисциплинарних истраживања ИИИ 45004 „Молекуларно дизајнирање наночестица контролисаних морфолошких и физичкохемијских карактеристика и функционалних материјала на њиховој основи".

Области интересовања су јој: цинк оксид, функционални нано-материјали, методе синтезе.

Библиографија мр Ана Станковић

Рад у врхунском међународном часопису (М21):

1. A. Stanković, S. Dimitrijević, D. Uskoković, *"Influence of size scale and morphology on antibacterial properties of ZnO powders hydrothemally synthesized using different surface stabilizing agents"*, Colloids and Surfaces B: Biointerfaces 102 (2013) 21-28, http://dx.doi.org/10.1016/j.colsurfb.2012.07.033

Радови у истакнутим међународним часописима (М22):

1. Stanković, Lj. Veselinović, S. D. Škapin, S. Marković and D. Uskoković, Controlled mechanochemically assisted synthesis of ZnO nanopowders in the presence of oxalic acid, Journal of Materials Science, 46, 2 (2011) 3716-3724, DOI: 10.1007/s10853-011-5273-6

2. A. Stanković, Z. Stojanović, Lj. Veselinović, S. D. Škapin, I. Bračko, S. Marković, D. Uskoković, "ZnO micro and nanocrystals with enhanced visible light absorption", Materials Science and Engineering B 177, 13 (2012) 1038-1045, http://dx.doi.org/10.1016/j.mseb.2012.05.013

Рад у часопису од националног значаја (М53):

1. S. Marković, A. Stanković, Lj. Veselinović, Z. Stojanovć, Dragan Uskoković, "Kreiranje morfologije i veličine čestica ZnO prahova", Tehnika, 5, 2012, 685. http://www.sits.rs/include/data/docs0374.pdf

Саопштење са међународног скупа штампано у изводу М34:

1. M.J. Lukić, A. Stanković, Lj. Veselinović, S.D. Škapin, S. Marković and D. Uskoković, Mechanochemically-assisted synthesis and characterization of Zr-doped hydroxyapatite nanopowders, Seventh International Conference on Mechanochemistry and Mechanical Alloying, INCOME 2011, 31. Avgust – 03. Septembar 2011, Herceg Novi, Montenegro. Book of abstracts, p.93.

2. A. Stanković, Lj. Veselinović, S. Marković, S. Dimitrijević, S.D. Škapin and D. Uskoković, Hydrothermal synthesis of ZnO nanostructures with different morphologies and their antimicrobial activity against *Escherihia coli* and *Staphylococus aureus* bacterial cultures, Thirteen annual conference Yucomat 2011, 5-9 Septembar 2011, Herceg Novi, Montenegro. Book of abstracts, p. 166.

3. M.J. Lukić, A. Stanković, Lj. Veselinović, S.D. Škapin, I. Bračko, S. Marković, D. Uskoković, Chemical precipitation synthesis and characterization of Zr-doped hydrohyapatite nanopowders, Thirteen annual conference Yucomat 2011, 5-9 Septembar 2011, Herceg Novi, Montenegro. Book of abstracts, p. 89.

4. A. Stanković, Ljiljana Veselinović, Smilja Marković, Suzana Dimitrijević, Srečo D. Škapin, Dragan Uskoković, Morphology controlled hydrothermal synthesis of ZnO particles and examination of their antibacterial properties on *Escherichia coli* and *Staphylococus aureus* bacterial cultures, Tenth Young Researchers' Conference — Materials Science And Engineering, Decembar 21-23, 2011. Belgrade, Serbia. Programe and book of abstracts, p.7.

5. A. Stanković, Z. Stojanović, Lj. Veselinović, I. Bračko, S.D. Škapin, S. Marković and D. Uskoković, Hydrothermal synthesis of ZnO nanopowders with a tailored particle morphology and improuved optical characteristics, Fourteenth annual conference Yucomyt 2012, 3-7 Septembar 2012, Herceg Novi, Montenegro, posterska sekcija. Book of abstracts p. 47.

6. A. Stanković, Z. Stojanović, Lj. Veselinović, S. Marković and D. Uskoković, Controlled hydrothermal processing of ZnO powders in the presence of PVP, 11th International Conference on Fundamental and Applied Aspects of Physical Chemistry, 24-26 Septembar 2012, Belgrade, Serbia, posterska sekcija, poster izložen pod rednim brojem H-4-P.

7. A. Stanković, Z. Stojanović, Lj. Veselinović, N. Abazović, S.D. Škapin, S. Marković, D. Uskoković, Influence Of Particle Size And Morphology Of ZnO Powders On Their Optical Properties, The joint event of The Eleventh Young Researchers' Conference Materials Science and Engineering and The First European Early Stage Researchers' Conference on Hydrogen Storage Belgrade, December 3-5 2012, Belgrade, Serbia. Book of abstracts p. 60.

ФАКУЛТЕТ ЗА ФИЗИЧКУ ХЕМИЈУ
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У В Е Р Е Њ Е

Да је Ч Е Л И К О В И Ћ (Војислав) А Н А, рођена 13.08.1979. године у Крушевцу, Република Србија, уписана школеке 1998/99. године на

Ф А К У Л Т Е Т У З А Ф И З И Ч К У Х Е М И Ј У

Универзитета у Београду , положила све испите предвиђене наставним планом и програмом и дипломирала дана 3. јуна **2005.** године са средњом оценом 8,29 (осам и 29/100) у току студија и оценом 10 (десет) на дипломском испиту и стекла високу стручну спрему и стручни назив

Д И П Л О М И Р А Н И Ф И З И К О Х Е М И Ч А Р

Уверење се издаје на лични захтев до издавања дипломе .

Уверење је ослобођено плаћања таксе .

Д Е К А Н
ФАКУЛТЕТА ЗА ФИЗИЧКУ ХЕМИЈУ

др Славко Ментус,проф

УНИВЕРЗИТЕТ У БЕОГРАДУ
ФАКУЛТЕТ ЗА ФИЗИЧКУ ХЕМИЈУ

БРОЈ 362009
Београд , 30. 11. 2009. године

На основу члана 171 . Закона о општем управном поступку и члана 5. Закона о стручним називима, по захтеву Ане Станковић издаје се следеће

У В Е Р Е Њ Е

Да је **СТАНКОВИЋ (Војислав) АНА** , рођена 13.08.1979.године, место

Крушевац, Република Србија , студент последипломских студија на

Универзитету у Београду
Ф А К У Л Т Е Т У З А Ф И З И Ч К У Х Е М И Ј У

на дан **13. новембра 2009 .** године , одбранила магистарски рад под називом :

" УТИЦАЈ ПАРАМЕТАРА ПРОЦЕСИРАЊА НА ТОК МЕХАНОХЕМИЈСКЕ СИНТЕЗЕ И СПРЕЧАВАЊЕ ПОЈАВЕ АГЛОМЕРАЦИЈЕ СИНТЕТИСАНИХ НАНОСТРУКТУРНИХ ПРАХОВА."

и тиме стекла академски назив

МАГИСТРА ФИЗИЧКОХЕМИЈСКИХ НАУКА

Уверење се издаје на лични захтев до издавања дипломе .

ДЕКАН
ФАКУЛТЕТА ЗА ФИЗИЧКУ ХЕМИЈУ
/Др Шћепан Миљанић, проф. /

ИНСТИТУТ ЗА НУКЛЕАРНЕ НАУКЕ
"ВИНЧА"
НАУЧНО ВЕЋЕ
Број: 401/15
18. 03. 2010. године
БЕОГРАД

На основу чл. 59., чл. 70. и чл. 82. Закона о научноистраживачкој делатности (**"Службени гласник РС", бр. 110/05),** на седници ***Научног већа Института за нуклеарне науке "Винча"*** одржаној 18. марта 2010. године, донета је

ОДЛУКА
О СТИЦАЊУ ИСТРАЖИВАЧКОГ ЗВАЊА
Мр Ана Станковић

стиче истраживачко звање
ИСТРАЖИВАЧ САРАДНИК

ОБРАЗЛОЖЕЊЕ

Мр Ана Станковић, сарадница Института техничких наука Српске академије наука и уметности, покренула је поступак за избор у истраживачко звање **ИСТРАЖИВАЧ САРАДНИК**.

На основу извештаја Комисије за оцену научноистраживачког рада именоване кандидаткиње формиране од ***Научног већа Института "Винча"*** и приложеног изборног материјала, утврђено је да **мр Ана Станковић** испуњава услове из чл. 69. Закона о научноистраживачкој делатности за стицање истраживачког звања **ИСТРАЖИВАЧ САРАДНИК**, па је одлучено као у диспозитиву одлуке.

ПРЕДСЕДНИК НАУЧНОГ ВЕЋА
ИНСТИТУТА "ВИНЧА"

Др Бојан Радак, виши научни сарадник

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Controlled mechanochemically assisted synthesis of ZnO nanopowders in the presence of oxalic acid

A. Stanković · Lj. Veselinović · S. D. Škapin · S. Marković · D. Uskoković

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Abstract In this study, the ZnO nanopowders were synthesized by mechanochemical processing with a successive thermal decomposition reaction. The initial reactants mixture of zinc chloride and oxalic acid was milled from 30 min to 4 h and thermally treated for 1 h at 450 °C. The influence of both, oxalic acid and the duration of milling, on the crystal structure, average crystallite size, average particle size, and the morphology of ZnO nanopowders were investigated. The qualitative analysis was performed using X-ray diffraction and Raman spectroscopy techniques. While the XRD analysis shows perfect long-range order and pure wurtzite structure of the synthesized ZnO powders, Raman spectroscopy indicates a different middle-range order; in addition, according to Raman spectra, it is found that lattice defects and impurities introduced in ZnO crystal structure depend on milling duration, in spite of applied thermal treatment. The particle size distribution was measured by laser diffraction, whereas the morphology of the powders was determined by scanning electron microscopy. Impurity contamination was studied using inductively coupled plasma analysis. The obtained results showed that the applied two-step method is appropriate for the synthesis of high crystalline ZnO nanopowders, with uniform spherical particles with diameter between 20 and 50 nm. Profound effect of aqueous solution of oxalic acid to prevent agglomeration of final product is presented.

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Introduction

Zinc oxide, ZnO, is an attractive material because of its unique properties, such as optical transparency, electrical conductivity, piezoelectricity, and near-UV emission [1–6]. In particular, nanosized ZnO has wide application in (UV) lasers, solar cells, varistors, gas sensors, transparent UV resistance coatings, photo-printing, sunscreen lotions, cosmetics, and medical creams.

In recent years, many studies have been carried out to develop methods for the synthesis of ZnO nanoparticles. The morphology of ZnO nanoparticles strongly depends on the presence of different types of surfactants in the reaction system [7]. Commonly used methods to produce ZnO nanopowder are: precipitation [8], sol–gel process [9], ultrasound-assisted synthesis [10], hydrothermal/solvothermal synthesis [11], and mechanochemical processing [12]. Mechanical milling has been extensively used for the synthesis of nanocrystalline materials because of its simplicity, relatively low-cost equipment, the large scale production, and applicability for variety of materials. Ball-milling technique operates at room temperature, which increases safety and reduces energy utilization. In general, mechanochemical processing has been recognized as a powerful technique for the synthesis of a wide range of semiconducting nanomaterials [12, 13], magnetic materials [14], carbon nanotubes [15], etc., which could otherwise be difficult to prepare using conventional methods. It has been reported that mechanical milling induces not only morphological and structural changes of the particles but also modify their optical [11] and electrical [16] properties. Most of the investigated mechanochemical synthesis procedures were preformed using mixtures of the appropriate metal salt or hydrated metal salt and an inert matrix (process controlling agents, PCA), which function is to prevent

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ZnO micro and nanocrystals with enhanced visible light absorption

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ABSTRACT

In this paper, we investigate the effect of the particle size and morphology on the optical properties of ZnO. A series of ZnO micro and nanocrystals were synthesized by the hydrothermal processing of zinc acetate dihydrate and sodium hydroxide as the starting materials, and polyvinylpyrrolidone (PVP) as the polymer surfactant. The particle size and morphology were tailored by adjusting the reactant molar ratios $[Zn^{2+}]/[OH^-]$, while the reaction temperature and the time remained unchanged. X-ray diffraction (XRD), transmission electron microscopy (TEM), selected area electron diffraction (SAED) and high-resolution TEM (HRTEM) have shown that the micro and nanocrystals have a high crystalline pure wurtzite-type hexagonal structure with nanosized crystallites. The size and morphology of the ZnO micro and nanocrystals were investigated by field emission scanning electron microscopy (FE-SEM), which showed a modification from micro-rods via hexagonal-faceted prismatic morphology to nanospheres, caused by simple adjustment of the reactant molar ratio $[Zn^{2+}]/[OH^-]$ from 1:1 to 1:5. The optical properties of the ZnO micro and nanocrystals, as well as their dependence on the particle size and morphology were investigated by Raman and ultraviolet–visible (UV–vis) diffuse reflectance spectroscopy (DRS). The UV–vis spectra showed that the modification of the particle size and morphology from nanospheres to micro-rods resulted in increased absorption, and a slight red-shift of the absorption edge (0.06 eV). Besides, the band gap energy of the synthesized ZnO micro and nanocrystals showed the red shift (~0.20 eV) compared to bulk ZnO. According to the results of a Raman spectroscopy, the enhanced visible light absorption of the ZnO micro and nanocrystals is related to two phenomena: (1) the existence of lattice defects (oxygen vacancies and zinc interstitials), and (2) the particle surface sensitization by PVP.

1. Introduction

Zinc oxide (ZnO) is a versatile, multifunctional material frequently used in high technology such as optoelectronic and electroluminescent devices, UV lasers, solar cells, piezoelectric transducers and gas sensors [1–5]. In addition, ZnO finds application in the areas like rubber industry and plastic processing, cosmetics and pharmacy; it is also used as an antimicrobial agent [6–14]. In many cases, the application of ZnO is based on its direct wide band gap (3.37 eV) and the large excitation binding energy (60 meV) at room temperature [1]. However, an energy gap of 3.37 eV (368 nm) means that ZnO can only absorb UV light [15]. Since solar visible light is a source of clean and cheap energy, while UV light makes no more than 3–5% of the total sunlight, ZnO-based materials capable for visible light photocatalysts are highly desirable [16]. Several approaches have been applied with the aim of changing the optical absorption properties and improving the visible light photocatalysis; they include the incorporation of transition metal ions into the crystal structure of a ZnO powder (since the presence of various intrinsic defects can give rise to deep acceptors or shallow donors and produce a red shift of the band gap [17]), the treatment of ZnO powders by applying hydrogen plasma technology to create a new absorption band in the visible-light region through the formation of oxygen vacancies, surface sensitization of ZnO particles to extend the spectral response into the visible region, etc.

Since the optical properties of materials are determined by the phase purity, homogeneity, particle size, morphology, as well as crystallinity, the possibility to control the synthesis process is of utmost importance. Several techniques such as precipitation [18], sol–gel process [19], spray pyrolysis [20], hydrothermal/solvothermal synthesis [21], mechanochemical [22], and microwave-hydrothermal processing [23] are used for the preparation of ZnO materials with a controlled morphology. Among them, hydrothermal synthesis is the most attractive especially due to the fact that it allows perfect control of purity, crystallinity,

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Influence of size scale and morphology on antibacterial properties of ZnO powders hydrothemally synthesized using different surface stabilizing agents

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ABSTRACT

Metal oxide nanoparticles represent a new class of important materials that are increasingly being developed for use in research and health-related applications. Although the antibacterial activity and efficiency of bulk zinc oxide were investigated in vitro, the knowledge about the antibacterial activity of ZnO nanoparticles remains deficient. In this study, we have synthesized ZnO particles of different sizes and morphologies with the assistance of different types of surface stabilizing agents – polyvinyl pyrrolidone (PVP), polyvinyl alcohol (PVA) and poly (α,γ, L-glutamic acid) (PGA) – through a low-temperature hydrothermal procedure. The characterization of the prepared powders was preformed using X-ray diffraction (XRD) method and field emission scanning electron microscopy (FE SEM), as well as Malvern's Mastersizer instrument for particle size distribution. The specific surface area (SSA) of the ZnO powders was measured by standard Brunauer–Emmett–Teller (BET) technique.

The antibacterial behavior of the synthesized ZnO particles was tested against gram-negative and gram-positive bacterial cultures, namely *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*), respectively. We compared the results of the antibacterial properties of the synthesized ZnO samples with those of the commercial ZnO powder. According to the obtained results, the highest microbial cell reduction rate was recorded for the synthesized ZnO powder consisting of nanospherical particles. In all of the examined samples, ZnO particles demonstrated a significant bacteriostatic activity.

1. Introduction

Nanoscale materials, i.e. those with at least one dimension smaller than 100 nm, have unique mechanical, chemical, electrical and thermal properties that make them very attractive for application in biotechnology, medicine and environment-related areas. Nanomaterials are already used as a very important component of sun creams, toothpastes, sanitary-ware coatings, textile fiber coatings, catalysts, fuel additives, water disinfectants and even food products [1,2]. Potential use of inorganic antimicrobial agents is of great interest because of their advantages over organic antimicrobial agents – namely, because of improved safety and stability [3]. In this context, metal oxides such as TiO_2, ZnO, MgO, and CaO are particularly significant because their use is accompanied with a high level of safety to humans. Some of the metal oxides e.g., MgO and CaO are essential minerals for human health [4,5]. Other oxides, such as TiO_2 and ZnO, are extensively used for personal care products [6], as well as in biomedical materials like dental composites [7] or prosthetic devices for hard tissue replacement [8]. Zinc oxide (ZnO) is currently being investigated as an antimicrobial agent in both microscale and nanoscale formulations. The obtained results indicate that ZnO nanoparticles show an apparently greater antibacterial activity [9–17] than ZnO microparticles [10]. The exact mechanism of the antibacterial action of ZnO nanoparticles is not entirely clarified. The assumptions range from the influence of reactive oxygen species (ROS) [10,11], zinc ion release [12], mechanical damage of the membrane cell wall through adhesion on the cell membrane [12,13] to the influence of the pH value of the reaction system. A higher concentration of smaller particles with a larger surface area ensures a more efficient antibacterial behavior [4,10,18] while the crystalline structure and particle shape probably have less influence [19]. However, the research of Yamamoto et al. [4] and Sawai et al. [13] has revealed that metal cations released from the powder and the mechanical destruction of the cell membrane have no effect on the antibacterial activity of ceramic powders. Furthermore, the pH value of powder dispersions in water or physiological saline was approximately 7.5, irrespective of the particle size of the powder. According to Yamamoto et al., the generation of hydrogen peroxide H_2O_2, (ROS)

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