

## Process Safety and Environmental Protection

Rok 2017, Volume 108

May



**Biao He, Xin-Sheng Jiang, Guo-Rui Yang, Jian-Nan Xu. *A numerical simulation study on the formation and dispersion of flammable vapor cloud in underground confined space.* Pages 1-11.**

A transient numerical study on the formation and dispersion of fuel vapor clouds in confined space was conducted. A liquid–gas phase-change model for fuel vapor formation was developed to better understand safe methods for fuel operation and storage. A liquid fuel leak was exposed to air, and a flammable fuel vapor–air mixture was formed. The simulation of the low-speed flowing and plum-like fuel vapor clouds was based on large eddy simulation. A typical case of gasoline leakage in underground fuel storage was also analyzed in detail. The results showed that following a gas leak in an underground storage tank, the vapor–air mixture will fill the space from the edges to the tank chamber exit and from the bottom up. In addition, the volume fraction at the top of the tank chamber remained below the 20% low explosion limit (LEL). The volume change in the vapor–air mixture with a volume fraction above 20% LEL can be divided into three periods: linear growth, space constraints, and critical increasing. This study provides an important insight for assessing flammable atmosphere risks after fuel leakage in a confined space and for determining the proper rescuing means and time.

- **Keywords:** Flammable vapor cloud; Confined space; Numerical simulation; Phase change; Dispersion

**Carmen Teodosiu, Francesc Castells. *Environmental Engineering and Management, Progresses and Challenges for Sustainability: An Introduction to ICEEM08.* Pages 1-6:**

This special issue of the Process Safety and Environmental Protection Journal contains articles that were presented at the 8th International Conference on Environmental Engineering and Management, ICEEM08 held between 9–12 September 2015, in Iasi, Romania. The series of International Conferences on Environmental Engineering and Management (ICEEM) was initiated and organized every 2 years, since 2002, by the Department of Environmental Engineering and Management of the “Gheorghe Asachi” Technical University of Iasi, aiming to bring together international researchers, academics, professionals and students, activating in the fields of environmental engineering and management. Two of the previous editions were organised in Hungary (ICEEM06) and Austria (ICEEM07), the ICEEM conference language being exclusively English. The 8th ICEEM edition co-organiser was the Environmental Biotechnology section of the European Federation of Biotechnology. ICEEM08 included 8 plenary conferences

held by renowned scientific personalities, 12 oral parallel sessions and 10 poster sessions, all grouped on the conference themes allowing the interaction of 209 international researchers, academics, professionals and young researchers from 22 countries. This special issue contains 14 articles with authors from five countries (France, Portugal, Romania, Republic of Moldova, Spain) that bring interdisciplinary research approaches to the following major conference themes: environmental monitoring, water and wastewater treatment, air pollution, soil pollution as well as improvement of process efficiency through synthesis and testing of new materials and process modeling.

- **Keywords:** Pollution monitoring; Water& wastewater; Air; Soil; Treatment; Sustainability

**Yassine Kadmi, Lidia Favier, Andrei Ionut Simion, Lacramioara Rusu, Mariana Liliana Pacala, Dominique Wolbert. *Measurement of pollution levels of N-nitroso compounds of health concern in water using ultra-performance liquid chromatography–tandem mass spectrometry. Pages 7-17.***

This paper reports the development of a highly sensitive analytical method combining solid-phase extraction (SPE) with ultra-high performance liquid chromatography coupled with tandem mass spectrometry (UHPLC–MS/MS), for the monitoring of ultra-trace levels of N-nitrosamines in water samples. Under optimized analytical conditions, chromatographic separation was performed in 3 min, in isocratic mode, using an Acquity UHPLC C18 column and a mobile phase consisting of acetonitrile, water, and formic acid (60:40:0.1, v/v/v) at a flow rate of 0.4 mL min<sup>-1</sup>. Electrospray ionization tandem interface was employed prior to mass spectrometric detection. Good linearity ( $R^2 \geq 0.9987$ ) and low limits of detection (0.04–0.4 ng L<sup>-1</sup>) and quantification (0.1–1.2 ng L<sup>-1</sup>) were obtained. The extraction recoveries ranged from  $98 \pm 1\%$  to  $100 \pm 1\%$  and the relative standard deviations were less than 1.53%. The matrix effect was between  $98 \pm 2$  and  $100 \pm 1\%$ . The obtained results clearly demonstrate that the developed method is accurate and highly sensitive for the simultaneous determination of N-nitroso-n-propylamine, N-nitrosomorpholine, N-nitrosomethylethylamine and N-nitrosodimethylamine at ultra-trace levels (ng L<sup>-1</sup>) in different types of water samples. Therefore, this method can be a useful analytical tool for future toxicological, water quality surveillance studies and for the investigation of drinking water quality.

- **Keywords:** Water quality; N-nitrosamines; Solid phase extraction; Ultra-high liquid chromatography–tandem mass spectrometry

**Anamaria Baci, Florica Manea, Aniela Pop, Rodica Pode, Joop Schoonman. *Simultaneous voltammetric detection of ammonium and nitrite from groundwater at silver-electrodecorated carbon nanotube electrode. Pages 18-25.***

Ammonium and nitrite are listed by Water Framework Directive as core parameters that should be monitored for the groundwater as drinking water source. This work describes the sensitive protocols for the simultaneous detection of ammonium and nitrite in water at a new silver-electrodecorated carbon nanotubes-epoxy composite electrode (Ag-CNT) using advanced voltammetric technique. A carbon nanotubes-epoxy composite electrode obtained by two-roll mill procedure was decorated electrochemically with silver nanoparticles. This new electrode displays excellent electrocatalytic activity towards the direct oxidation of ammonium and nitrite at well separated less potential values (+0.15 V/SCE for ammonium and +0.7 V/SCE for nitrite). Very good detection sensitivities (0.613 mA mM<sup>-1</sup> for ammonium and 0.980 mA mM<sup>-1</sup> for nitrite) and the lowest limits of detection (1 μM for ammonium and 0.7 μM for nitrite) were achieved by differential-pulsed voltammetry (DPV) under optimum operating conditions of 0.05 V step potential,

0.2 V modulation amplitude and the scan rate of 0.05 V s<sup>-1</sup>. This detection protocol was successfully applied to the simultaneous determination of ammonium and nitrite in groundwater samples, and the results were found to be consistent with the values obtained by the standardized spectrophotometry methods.

- **Keywords:** Ammonium; Nitrite; Simultaneous voltammetric detection; Silver-electrodecorated carbon nanotubes-epoxy composite electrode; Electrochemical techniques; Groundwater

**Corina Orha, Rodica Pode, Florica Manea, Carmen Lazau, Cornelia Bandas. *Titanium dioxide-modified activated carbon for advanced drinking water treatment. Pages 26-33.***

This study reported a new anatase TiO<sub>2</sub>-modified granular activated carbon (GAC-TiO<sub>2</sub>) synthesized by microwave-assisted hydrothermal method. The composite was characterized morpho-structurally by X-ray diffraction (XRD), scanning electron microscopy (SEM), Fourier transform infrared (FTIR) spectra and Brunauer–Emmett–Teller (BET) measurement. GAC-TiO<sub>2</sub> composite was used for the removal of humic acids (HA) from water by the photocatalysis under UV irradiation in comparison with the sorption process. Kinetics results correlated with Zeta potential results allowed elucidating some mechanistic aspects. GAC-TiO<sub>2</sub> composite revealed high photoactivity for HA degradation and mineralization. A self-cleaning activity of the composite proved in this study makes it very remarkable in developing next generation of filtering system avoiding its fouling in the drinking water treatment technology.

- **Keywords:** Titanium dioxide-modified activated carbon; Humic acid; Sorption; Photocatalysis; Advanced drinking water treatment; Kinetics model

**Catalina Filote, Gabriela Ungureanu, Rui Boaventura, Sílvia Santos, Irina Volf, Cidália Botelho. *Green macroalgae from the Romanian coast of Black Sea: Physico-chemical characterization and future perspectives on their use as metal anions biosorbents. Pages 34-43.***

Over the last years, algal blooms occurrences have increased on the Romanian Black Sea coast. In this study, *Ulva rigida* and *Cladophora sericea* green algae were used to investigate the removal of As(III), As(V), Sb(III), Se(IV) and Se(VI) in aqueous solution. In virgin forms, both macroalgae showed good perspectives for application on antimony and selenium uptake from water, although no significant efficiency towards arsenic was observed. Several treatments were applied to the algae to eventually enhance their adsorption capacity. Potentiometric titrations and infrared spectroscopy confirmed favorable chemical modifications in algae surface due to HDTMA and ammonium treatments, although no considerable increase in the biosorption ability was found. *C. sericea*, in virgin form, was selected for further studies on the uptake of Se(IV) and Se(VI). The best results for Se(IV) removal (0.5 mg/g) were found at pH 2–4 and for Se(VI) (0.2 mg/g) at pH 2–3. The equilibrium isotherm for the adsorption of Se(IV), at pH 2 and 20 °C, reported a maximum experimental adsorbed amount of 0.74 mg/g and a Langmuir monolayer capacity of 4 mg/g, which are substantial values considering that the biosorbent (dead marine seaweeds) is a residue and requires no significant processing before use.

- **Keywords:** Green macroalgae; Biosorption; Arsenic; Selenium; Antimony

**Raluca Maria Hlihor, Hugo Figueiredo, Teresa Tavares, Maria Gavrilescu. *Biosorption potential of dead and living *Arthrobacter viscosus* biomass in the removal of Cr(VI): Batch and column studies. Pages 44-56.***

Batch experiments were conducted with dead and living *Arthrobacter viscosus* biomass for Cr(VI) removal from aqueous solution. Both dead and living cells successfully reduced Cr(VI) to Cr(III) from aqueous solution in highly acidic pH (pH 1 and 2) with an efficiency of 100% for aqueous solutions having the initial concentrations of Cr(VI) lower than 100 mg/L. Langmuir isotherm and kinetic models based on reduction could simulate chromium removal at 5 and 8 g/L biosorbent dosages and in highly acidic pH conditions (pH 1–2). Further, the potential use of the *A. viscosus* biomass was examined in an open system, where Cr(VI) removal from aqueous solution was performed by a bacterial biofilm supported on a new type of polyethylene supports. The experiment showed a favorable uptake of chromium ions bound to the biomass, of 20.37 mg/g, with high potential for scaling up. This study showed that the reduction of toxic Cr(VI) to the less toxic Cr(III) by *A. viscosus*, in batch and continuous modes is an efficient and promising technique for wastewaters polluted with chromium.

- **Keywords:** Cr(VI) removal/reduction; Biosorption; *A. viscosus*; Bacterial biofilm; Aqueous solution

**Igor Cretescu, Tudor Lupascu, Ingrid Buciscanu, Tudorel Balau-Mindru, Gabriela Soreanu. *Low-cost sorbents for the removal of acid dyes from aqueous solutions*. Pages 57-66.**

Two activated carbons (ACs) derived from apple wood (AWAC) and peach stone (PSAC), and one keratinous material extracted from hydrolyzed wool (WHA) were tested for their adsorption capacity for Acid Red 337 (AR) and 1:2 chromium complex of Acid Blue 349 (AB). A commercial granular activated carbon (GAC) was chosen as reference sorbent. The sorbent characteristics, the dye concentration, the contact time and the working pH were the factors taken into consideration. The SEM images of AWAC and PSAC show different morphologies and pore structures. FTIR spectra of the WHA material did not indicate any drastic disruption of keratin macromolecule. The AR dye exhibited higher uptake as compared with the AB dye for all sorbents. The sorption capacity of the tested materials increased in sequence: AWAC < PSAC < WHA, with maximum uptake of 235.02 mg AR /g WHA and 122.83 mg AB /g WHA. Lowering the pH from 5 to 3 increased the dye uptake for all tested solids, to as much as 120.26%, for the AWAC-AB couple. The adsorption kinetics obeys the pseudo-second order model. The Langmuir model best fitted the experimental sorption isotherms and the free adsorption energy calculated from the Dubinin–Radushkevich model indicated physisorption. The present study suggests that the investigated waste-derived sorbents are effective for the removal of low molecular weight acid dyes from water.

- **Keywords:** Acid dyes; Sorption; Lignocellulosic waste; Keratin waste; Isotherm; Kinetic

**Lavinia Lupa, Adriana Popa, Ecaterina Stela Dragan, Mihaela Ciopec, Adina Negrea, Petru Negrea. *Adsorption performance of the organic solid support impregnated with ionic liquid in the removal process of Tl(I) from aqueous solutions*. Pages 67-73.**

In this article, we have presented the studies regarding the improvements of the adsorption performance of a styrene-12% divinylbenzene copolymer functionalized with aminophosphonate groups in the removal process of thallium ions from aqueous solutions, by impregnation of the solid support with trihexyl(tetradecyl)phosphonium chloride (Cyphos IL-101). The use of ionic liquid impregnated polymer as adsorbent in the removal process of radionuclides presents higher adsorption performance because, in this case, the advantages of the ionic liquids are combined with the properties of the solid support. Until now the ionic liquids were intensive studied in the removal process of radionuclides from aqueous solutions but using the liquid–liquid extraction. In our case

these are used in the solid–liquid separation process, a smaller quantity of ionic liquids being used (which decrease the cost of the adsorption process), and the loss of the ionic liquids in the aqueous phase being avoided. The ultrasonication method used for the impregnation of the ionic liquids onto the solid support is also a new and original one. The impregnation of the solid support with Cyphos IL-101 significantly increased its adsorption performance in the removal process of Tl(I) ions from aqueous solutions.

- **Keywords:** Thallium; Adsorption; Ionic liquid; Impregnation; Organic solid support; Kinetic study; Equilibrium

**Carmen Zaharia. *Decentralized wastewater treatment systems: Efficiency and its estimated impact against onsite natural water pollution status. A Romanian case study. Pages 74-88.***

The paper proposes discussions of some concrete datasets resulted for three solutions of wastewaters management systems applied in case of a Romanian petroleum chemical company. These management options, differing especially in type (centralized or decentralized system) and wastewaters treatment system, were emphasized, mainly by real datasets on treatment performance, polluting species removals, risk of some residuals in treated effluents and natural watercourse nearby, but also environmental impact assessment, using the alternative methodology of global pollution index (I\*GP). Interpreting datasets based on in-time analyzed physical-chemical quality indicators and river characteristics, it was estimated the standard quality classification of receiving watercourse as 'medium' (water quality indices, WQI = 55.58 – 67.47), affected more or less by treated effluents discharged in it. The environmental risks of some selected residuals in treated effluents and natural aquatic receptor were assessed by the risk quotient (RQ) which appreciated the risk of residuals toward aquatic life as no to low-medium level, with few exceptions. The impact assessment results conclude an admissible pollution status of natural water receptor due to company wastewaters mechanical–chemical–biological treatment plant activities, in decentralized (I\*GP = 1.73) and centralized (I\*GP = 1.83) system, but generating discomfort effects to aquatic life due to only mechanical–chemical treatment plant operating in decentralized system (I\*GP = 2.205). Direct discharge of un-treated industrial wastewaters had been interdicted. These real results underline that decentralized systems are reliable, qualitatively efficient and costly effective, offering long-term solution, and that all wastewaters management strategies of petroleum chemical company had been adapted to specific on-site functioning situations.

- **Keywords:** Onsite decentralized treatment system; Estimated impact and risk; Global pollution index; Petroleum chemical company; Risk quotient; Standard water quality indices

**C. Teodosiu, V. Ilie, R. Teodosiu. *Modelling of volatile organic compounds concentrations in rooms due to electronic devices. Pages 89-98.***

The objective of this study is to develop an approach concerning the integration of volatile organic compounds (VOCs) emissions due to office equipment in computational fluid dynamics (CFD) simulations, in order to assess the indoor air quality (IAQ). The transport and diffusion phenomena of VOCs are taken into account in the CFD model by means of conservation equations of the mass fraction, written for each VOC that is intended to be considered in the simulation. These equations include source terms of mass for each VOC, based on VOC generation rates of different sources considered in the numerical model (computers, monitors, and laser printers). On the other hand, these equations are added to the basic equations describing turbulent confined non-isothermal flows (conservation of mass, momentum, energy, and turbulent quantities) in CFD modelling. The numerical model is applied in this study for a small office, taking into account a conventional mixing ventilation system (low air flow rates with different air

supply temperatures). Health hazard assessments are accomplished by taking into account in the CFD model the indoor levels of the following five VOCs: benzaldehyde, ethylbenzene, o-xylene, styrene, and toluene. The CFD model proposed in this study allows achieving values of VOCs concentrations throughout the entire indoor environment. Consequently, results are presented in terms of benzaldehyde, ethylbenzene, o-xylene, styrene, and toluene concentration contours in the office, as well as mean and peak values of these VOCs in the occupied zone of the room. The results show that the estimated VOCs concentration levels due to office equipment are far below the set threshold limit values. However, the reported maximum concentrations of VOCs taken into account in the occupied zone tend to approach in some measure levels of concern with respect to odour or sensory irritation. Finally, the numerical description of VOCs sources for CFD modelling developed in this work may be extended for other indoor VOCs sources. As a result, the numerical approach proposed in this study can lead to relevant health hazard analyses, being an appropriate alternative to experimental investigations, challenging to perform in situ.

- **Keywords:** Computational fluid dynamics modelling (CFD); Indoor air quality (IAQ); Volatile organic compounds (VOCs); Indoor exposure; Ventilation efficiency; Health hazard

**Marius Popescu, Emilio Rosales, Ciprian Sandu, Jéssica Meijide, Marta Pazos, Gabriel Lazar, M<sup>a</sup> Angeles Sanromán. *Soil flushing and simultaneous degradation of organic pollutants in soils by electrokinetic-Fenton treatment. Pages 99-107.***

This study focuses on the evaluation of a combination of electrokinetic technology and Fenton's process to remediate a soil polluted with organic compounds. To determine the influence of the several variables such as hydrogen peroxide dosage, iron soil concentration and porosity, different experiments using kaolinite spiked by Rhodamine B were performed. The use of this coloured sample permitted an easy monitoring of the oxidation reactions across the soil bed. From the obtained results, it is concluded that the highest colour removal rate was reached when a solution of hydrogen peroxide around 10% was used, and slight influence of iron soil concentration was detected at the range of concentrations used in these experiments. In all cases, citric acid was added in the anolyte and catholyte solutions in order to solubilize the iron as Fe-citrate complex and to keep the pH in acid environment favouring that the Fenton's reactions take place into the soil. Based on these preliminary experiments, the electrokinetic-Fenton process was applied to total petroleum hydrocarbons (TPH) polluted soil. After 15 and 27 days of treatment, a homogeneous removal of pollutants, around 54.4% and 58.2% of TPH removal efficiency, was reached, respectively. In addition, the Microtox bioassays confirmed the reduction of the *Vibrio fischeri* inhibition after the soil treatment. Summing up, in situ electrokinetic-Fenton treatment seems to be a suitable technique for the remediation of organics such as hydrocarbons present in polluted soils.

- **Keywords:** Electrokinetic-Fenton; Hydrogen peroxide; Iron; Porosity; Rhodamine B; TPH

**Camelia Smaranda, Maria-Cristina Popescu, Dumitru Bulgariu, Teodor Mălușan, Maria Gavrilescu. *Adsorption of organic pollutants onto a Romanian soil: Column dynamics and transport. Pages 108-120.***

The main objectives of this study were to obtain data and assess the processes of transport and migration of organic pollutants in natural soils, in particular adsorption-desorption, in dynamic mode. The experiments were conducted to study the effects of some significant parameters such as soil column height, influent flow rate and initial concentration of the dye in influent solution on Congo red (CR) behavior in a Romanian

soil. Some models such as: Thomas, Adams–Bohart, Wolborska, Yoon–Nelson and BDST were applied to predict the behavior of CR in a protoil collected from NE of Romania. Column experiments were performed in order to reproduce field conditions, with the goal to obtain information not available from batch studies. Breakthrough curves were used to evaluate the mobility of CR in soil columns. It was observed that, at low CR concentration there is a relative slower transport determined by a declining in diffusion coefficient and mass transfer coefficient values. The saturation time was achieved earlier and the breakthrough time appears quicker when the initial CR concentration increases. This phenomenon can be explained by the larger number of active adsorption centers covered at higher concentrations of CR. The transport parameters of CR depend on the initial dye concentration in solution and influent flow rate, as well as soil column height. This behavior confirms the high mobility potential of CR in the investigated soil. Desorption studies using different eluents showed that the rate of desorption was higher in the first minutes of the process, when more than 80% of the uptaken CR molecules were desorbed, showing a high potential mobility and transport in investigated soil.

- **Keywords:** Adsorption; Breakthrough curve; Congo red; Mobility; Organic dyes; Soil bed column

**Minodora Manu, Raluca Ioana Băncilă, Virgil Iordache, Florian Bodescu, Marilena Onete. *Impact assessment of heavy metal pollution on soil mite communities (Acari: Mesostigmata) from Zlatna Depression – Transylvania. Pages 121-134.***

The heavy metal pollution level of soil from twelve grasslands and its impact on soil mite communities was assessed. The impact assessment was investigated, taking into account the distance from pollution source, the degree of pollution and the cumulative influence of heavy metals and other environmental variables. These variables were: temperature, humidity, acidity, carbon content, nitrogen total, C/Nt ratio, slope, altitude, vegetation cover, exposition and soil type. The measured concentrations of all heavy metals for the investigated grasslands exceeded the reference values according to the national legislation. In order to make a comparison between investigated grasslands and in order to classify the ecosystems, total metal load was calculated. Three groups of grasslands were established based on different degrees of soil pollution and taking into account the total metal load. In total, 66 Mesostigmata species were identified, with 961 individuals. Mite communities from the most polluted areas were distinguishable from those from less polluted grasslands. Some heavy metals (e.g. As, Cu, Pb and Zn) influenced the soil mites from highly polluted ecosystems, while Mn and other environmental variables (altitude and soil humidity) were strongly correlated with invertebrate communities from the medium polluted areas. Soil temperature was the main factor influencing mites from the less polluted ecosystems.

- **Keywords:** Soil mite communities; Heavy metal pollution; Grassland; Environmental variables; Distance; Metal load

**Andreea Diaconu, Ioan Țenu, Radu Roșca, Petru Cârlescu. *Researches regarding the reduction of pesticide soil pollution in vineyards. Pages 135-143.***

Phytosanitary treatments with pesticides are widely used for pest and disease control in vineyards. When performing the treatment an important part of the dispersed pesticide falls on the ground, affecting the microorganism and fauna, producing quantitative and qualitative changes in both the structure of the edaphic population and in its physiological activities. In order to diminish soil pollution experimental field tests concerning pest and disease control in vineyard were performed, using a spraying machine provided with an equipment which aims to recycle the pesticide liquid that is not

retained by the vine foliar system. The equipment was built up based on a commercial TARAL 200 PITON TURBO air-assisted sprayer, used for pest and disease control in vineyards and orchards and was equipped with two recycling panels, placed on each side of the vine row. CFD simulations were used in order to optimize the dimensions, geometry and position of the recycling panels. The experiments were performed for different vegetation stages, forward speeds and operating pressures; for the first vegetation phase (bud opening), the pesticide recycled volume reached 45% of the total applied volume; in phases VI and VII the recycling rate was lower than 25%. For the vegetation phase V and for the forward speeds and operating pressures taken into account the quality of the treatment was evaluated using the mean foliar deposit. The results obtained by the means of ImageJ processing software indicated an adequate operating process of the spraying equipment; the values of this index were ranged between 21.4% and 36.2% for the upper side of the leaves and between 18.6% and 29.7% for the lower side of the leaves. The best indices were attained for low forward speed and an operating pressure of 0.6 MPa.

- **Keywords:** Spraying machine; Pesticide; Pollution; Soil; Recycling equipment; Recycling rate

**Anca Vasile, Mariana Scurtu, Cornel Munteanu, Mircea Teodorescu, Mihai Anastasescu, Ioan Balint. *Synthesis of well-defined Pt nanoparticles with controlled morphology in the presence of new types of thermosensitive polymers.* Pages 144-152.**

Efficient preparation of stable colloidal suspensions of platinum nanoparticles was achieved by reduction of Pt precursor ( $H_2PtCl_6 \cdot 6H_2O$ ) in the presence of new thermosensitive polymers with triblock copolymer structure consisting of a poly(ethylene glycol) (PEG) central block and poly(N-isopropylacrylamide-co-N-t-butylacrylamide) statistical copolymer as side chains. The predominant shape and size of platinum nanoparticles was controlled by changing the N-t-butylacrylamide (TB)/N-isopropylacrylamide (NIPAM) mole ratio in the capping polymer. The triblock copolymer side chain composition was varied by increasing gradually the TB molar percentage from 0, 3 and 6 mol%. The molar ratio between the capping polymer, calculated based on the monomer unit, and platinum cation was in all cases 10:1. The morphology, shape and mean size of colloidal particles was determined from transmission electron microscopy (TEM) micrographs. The best morphological control was obtained using the thermosensitive polymer with 3 mol% TB within the side blocks, and the optimal reduction temperature for this polymer was 34 °C (below the critical temperature). The surface area of exposed platinum nanoparticles dispersed on  $TiO_2$  was estimated by CO pulse chemisorption. The photocatalytic hydrogen generation over Pt/ $TiO_2$  materials under solar irradiation was evaluated. The hydrogen production rate was found to be sensitive to the particle size.

- **Keywords:** Platinum nanoparticles; Thermosensitive polymers; TEM;  $H_2$  production; Synthesis method; Shape control; Particle size; Photocatalysis