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# Distributed Feedback Grating Fabricated From Hybrid Polymer Precursor Gel by employing short-pulse laser interference for Photo-pumped laser application

**Polymer Advanced Technology Vol 23(9), 1264-1270,  
September 2012**

DOI : 10.1002/ pat.2039

Rahmat Hidayat, Sahrul Hidayat, Fitri Fitrialawati, Herman,  
May On Tjia, Akikho Fujii, Masanori Ozaki

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# Polymers for Advanced Technologies

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ISI Journal Citation Reports © Ranking: 2015: 36/85 (Polymer Science)

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## Overview

### Aims and Scope

POLYMERS FOR ADVANCED TECHNOLOGIES is published in response to recent significant changes in the patterns of materials research and development. Worldwide attention has been focused on the critical importance of materials in the creation of new devices and systems. It is now recognized that materials are often the limiting factor in bringing a new technical concept to fruition and that polymers are often the materials of choice in these demanding applications. A significant portion of the polymer research ongoing in the world is directly or indirectly related to the solution of complex, interdisciplinary problems whose successful resolution is necessary for achievement of broad system objectives.

POLYMERS FOR ADVANCED TECHNOLOGIES is focused to the interest of scientists and engineers from academia and industry who are participating in these new areas of polymer research and development. It is the intent of this journal to impact the polymer related advanced technologies to meet the challenge of the twenty-first century.

POLYMERS FOR ADVANCED TECHNOLOGIES aims at encouraging innovation, invention, imagination and creativity by providing a broad interdisciplinary platform for the presentation of new research and development concepts, theories and results which reflect the changing image and pace of modern polymer science and technology.

POLYMERS FOR ADVANCED TECHNOLOGIES aims at becoming the central organ of the new multi-disciplinary polymer oriented materials science of the highest scientific standards. It will publish original research papers on finished studies; communications limited to five typewritten pages plus three illustrations, containing experimental details; review articles of up to 40 pages; letters to the editor and book reviews.

Review articles will normally be published by invitation. The Editor-in-Chief welcomes suggestions for reviews.

**Review Articles.** *Polymers for Advanced Technologies* publishes high quality reviews on topics of current interest in all areas of advanced polymer processing, synthesis, and applications of new polymer-centric innovations. Areas of particular interest are biomedical devices, flexible electronics, neural interfaces, organic electronics, soft photonics, polymer nanocomposites, micro- and nano-fabrication, biological molecules

including DNA, polymers in advanced energy applications, and other exciting uses of polymers tackling grand challenges across disciplines. Articles may either provide a complete, broad review of a topic, or may concentrate on the author's own work, placing that work in the context of the broader field. Several select issues published by PAT will be topical issues consisting of invited papers.

NOTE: *Polymers for Advanced Technologies* does not accept papers dealing exclusively with the synthesis and/or characterization of polymers except in cases where the focus is upon an advanced technology.

## **TOPICS COVERED**

### **Radiation-Related Polymers**

- Radiation-sensitive and radiation-stabilized polymers
- Polymers for microwave absorption
- Degradation
- Photo-electro conductive polymers
- Electro-optics and nonlinear optics
- Dielectric, ferroelectric and electric applications of polymers.

### **Advanced Structures**

- Liquid-crystalline and high-performance polymers and fibers
- Polymeric gels and networks
- Blends and alloys
- Engineering polymers
- Composites, adhesives, interphases and interfaces
- New elastomers, coatings and sealants
- Flammability, flame retardance and flame resistance
- Polymeric membranes, thin films and nanofilms
- Polymeric catalysts.

### **Polymers for Biosystems**

- Polymers for biosensors and affinity chromatography
- Polymers for drug release and drug carrier systems
- Biocompatible polymers and polymer surfaces
- Bioabsorbable and biodegradable polymers
- Microfabrication and novel processing
- Polymers in biotechnology
- Biologically engineered polymers.

### **Materials**

The journal will deal with organic, inorganic, multiphase and composite polymers which include amorphous and crystalline, in solid, liquid and gaseous phases with properties of potential for advanced technologies. Among the industries for which the journal is of importance are: electric, electronic, information and communication industries, aerospace-related industries, chemicals, energy, plastics, fibers and textiles, engineering resins and rubber products, automotive and packaging, imaging industries, devices and integrated circuits, specialty consumer products, agricultural and pharmaceutical industries.

### **Readership**

Industrial and academic scientists and engineers in the following fields: materials science · polymer science · inorganic chemistry · physical chemistry · polymer physics · organic chemistry · biochemistry · chemical engineering · plastics engineering · mechanical engineering · biotechnology · molecular modelling and design

## **Keywords**

polymers, advanced technologies, radiation, biosystems, composites, liquid-crystal, high-performance, fiber, gel, network, membranes, nanofilms, journal, online journal, Wiley Online Library

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- Advanced Polymers Abstracts (ProQuest)
- CAS: Chemical Abstracts Service (ACS)
- Ceramic Abstracts/World Ceramic Abstracts (ProQuest)
- Chemical Abstracts Service/SciFinder (ACS)
- ChemWeb (ChemIndustry.com)
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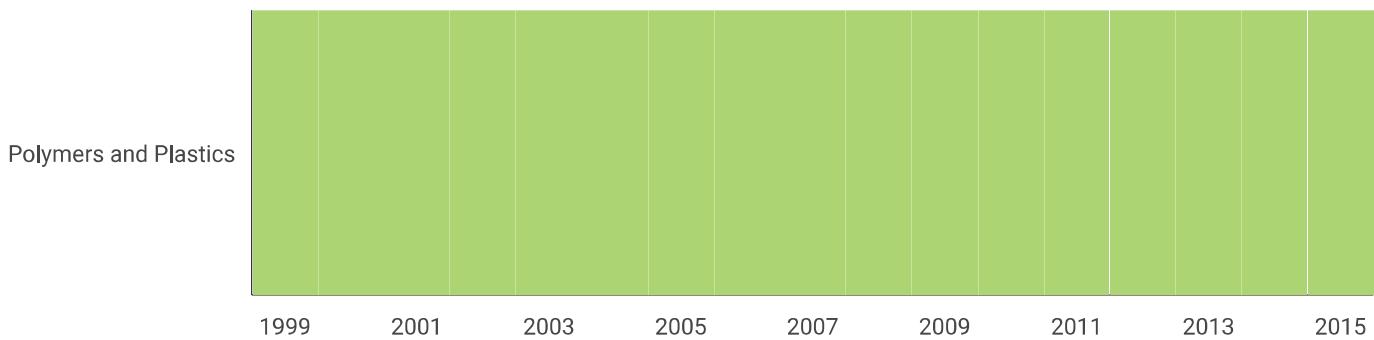
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**Scope** POLYMERS FOR ADVANCED TECHNOLOGIES is published in response to recent significant changes in the patterns of materials research and development. Worldwide attention has been focused on the critical importance of materials in the creation of new devices and systems. It is now recognized that materials are often the limiting factor in bringing a new technical concept to fruition and that polymers are often the materials of choice in these demanding applications. A significant portion of the polymer research ongoing in the world is directly or indirectly related to the solution of complex, interdisciplinary problems whose successful resolution is necessary for achievement of broad system objectives. ([source](#))

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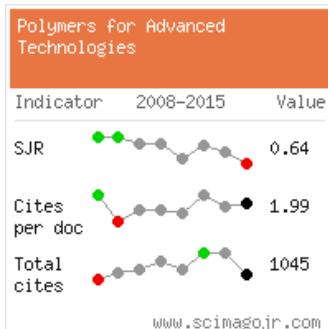
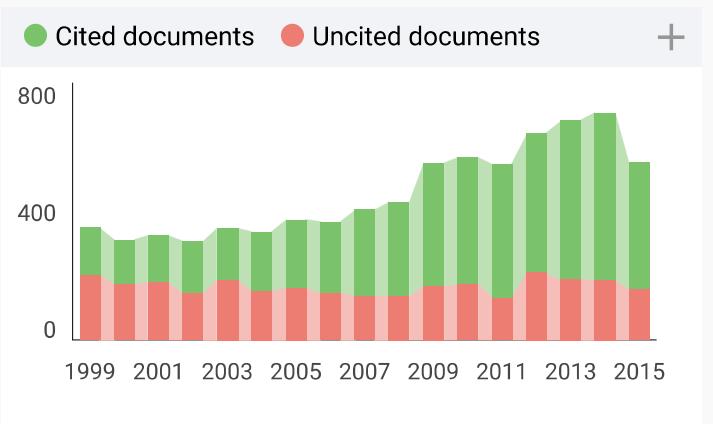
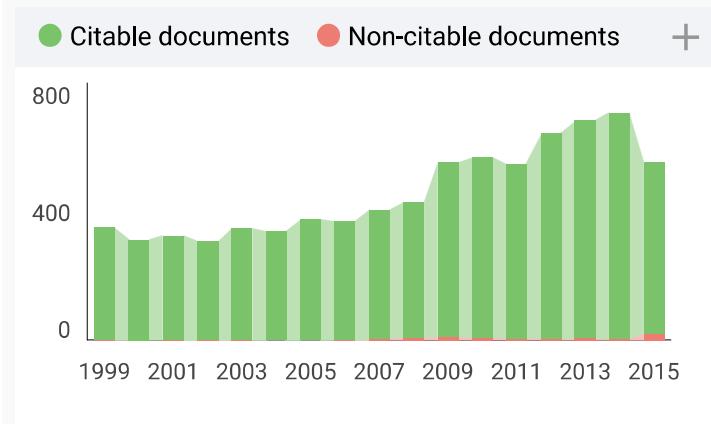
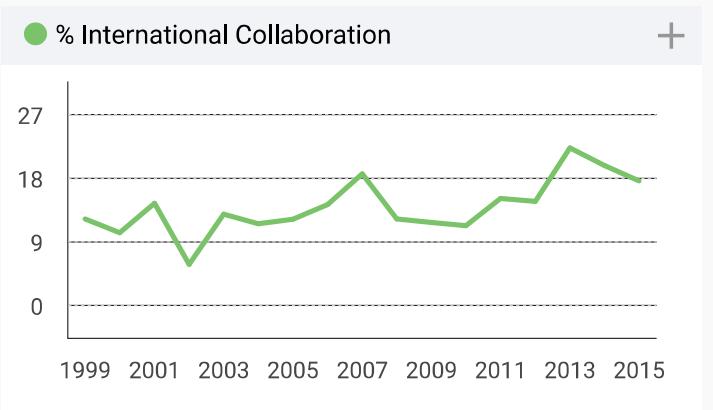
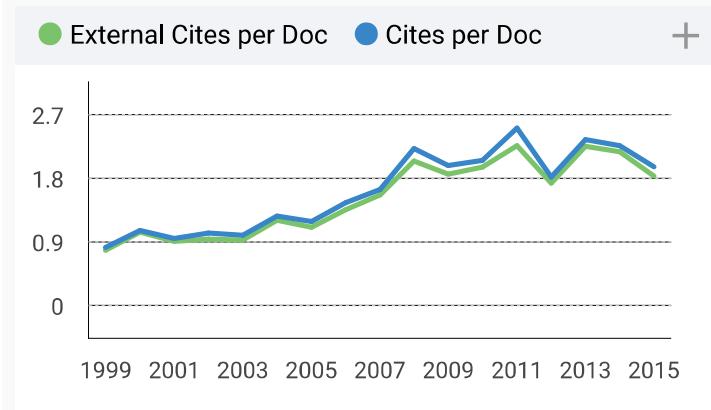
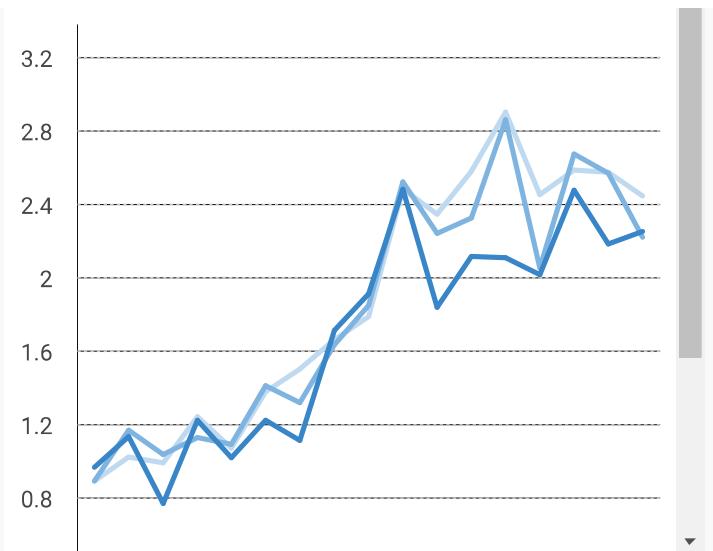


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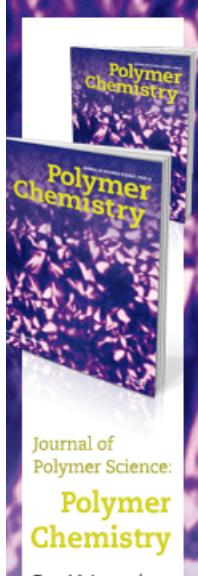
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##### Carbon nanotube-filled ethylene/vinylacetate copolymers: from *in situ* catalyzed polymerization to high-performance electro-conductive nanocomposites

Giuliana Gorrasi, Stéphane Bredeau, Chiara Di Candia, Giovanni Patimo, Salvatore De Pasquale and Philippe Dubois  
Article first published online: 18 OCT 2011 | DOI: 10.1002/pat.2064

[Abstract](#) | [Full Article \(HTML\)](#) | [PDF\(437K\)](#) | [References](#) | [Request Permissions](#)

##### Effect of alkali and ultraviolet aging on physical, thermal, and mechanical properties of fibers for potential use as reinforcing elements in glass/silicate composites

M. H. Akonda, B. K. Kandola and A. R. Horrocks  
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##### Thermal conductivity epoxy resin composites filled with boron nitride

Junwei Gu, Qiyu Zhang, Jing Dang and Chao Xie  
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##### Enhancement of properties of polyimide/silica hybrid nanocomposites by benzimidazole formed hydrogen bond

Peng Zhang, Yi Chen, Guoqiang Li, Longbo Luo, Yuwei Pang, Xu Wang, Chaorong Peng and Xiangyang Liu  
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##### Comparison of alumina and boehmite in (APP/MPP/metal oxide) ternary systems on the thermal and fire behavior of PMMA

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**Preparation and characterization of conductive chitosan–ionic liquid composite membranes**  
Yubing Xiong, Hong Wang, Chengyi Wu and Rongmin Wang  
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**Micelles formed by self-assembling of low molecular weight phosphorylcholine-containing poly(L-lactide)**  
Yuanwei Chen, Jing Chen, Yanjun Liu, Xianglin Luo and Suming Li  
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**Properties of rubber filled with montmorillonite with various surface modifications**  
Jana Hrachová, Peter Komadel, Ivica Janigová, Miroslav Šlouf and Ivan Chodák  
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**Preparation of bow tie-type methacrylated poly(caprolactone-co-lactic acid) scaffolds: effect of collagen modification on cell growth**  
Gülay Bayramoğlu, Nilhan Kayaman-Apohan, Memet Vezir Kahraman, Sabriye Karadenizli, Serap Erdem Kurucu and Atilla Güngör  
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**Structure and properties of the graft copolymer of starch and *p*-hydroxybenzoic acid using horseradish peroxidase**  
Shenghua Lv, Rui Gong and Yanfen Ma  
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**Synthesis and characterization of electroactive epoxy-based interpenetrating polymer network gel**  
Tapan Kanai, Kusum Pandey and A. B. Samui  
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**Synthesis of gradient polymer by using polysiloxane-based photoinitiator**  
Xiu-hua Lai, Fang Sun, Rui-Xue Yin, Gui-Ping Ma and Jun Nie  
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**New potentially environmentally friendly copolymer of styrene and maleic acid—castor oil monoester**  
Xamxikamar Mamat, Yonglei Wang and Wumanjiang Eli  
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**Novel biphasic structured composite prepared by *in situ* silica filling in natural rubber latex**  
Atitaya Tohsan, Pranee Phinyocheep, Sumet Kittipoom, Wanwisa Pattanasiriwisawa and Yuko Ikeda  
Article first published online: 13 SEP 2011 | DOI: 10.1002/pat.2051  
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**Efficacy of clay content and microstructure of curing agents on the structure–property relationship of new-generation polyurethane nanocomposites**  
Pradip K. Maji and Anil K. Bhowmick  
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**Processing and thermal properties evaluation of silylated apophyllite-filled epoxy nanocomposite**  
Chenggang Chen, J. Langat and D. Raghavan  
Article first published online: 7 SEP 2011 | DOI: 10.1002/pat.2047  
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***In situ* preparation of cross-linked polystyrene/poly(methyl methacrylate) blend foams with a bimodal cellular structure**

Dominik Kohlhoff, Abacha Nabil and Masahiro Ohshima  
Article first published online: 30 AUG 2011 | DOI: 10.1002/pat.2053

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**Electrical resistance and heat generation of polypyrrole-coated polyacrylonitrile nanofibrous and regular fibrous mats**

Azam Oroumei, Hossein Tavanai and Mohammad Morshed  
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**Preparation and transport properties of PPy/PVDF composite membrane**

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**Preparation of phenolic microspheres in water/"water" system**

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**Polyvinyl alcohol/acrylamide based photopolymer composition as recording medium for high-resolution volume-phase holograms**

Alips Srivastava, Shilpa M. Sawant, Lata Mainali, Rahul Bhatt, A. K. Gupta and A. B. Samui  
Article first published online: 23 AUG 2011 | DOI: 10.1002/pat.1999

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**Fabrication and characterization of electrospun silk fibroin/TiO<sub>2</sub> nanofibrous mats for wound dressings**

Win-Chun Jao, Ming-Chien Yang, Chien-Hong Lin and Chi-Chuan Hsu  
Article first published online: 21 AUG 2011 | DOI: 10.1002/pat.2014

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**Preparation of hierarchical polyaniline nanotubes based on self-assembly and its electrochemical capacitance**

Fen Ran, Yong-tao Tan, Ji Liu, Lei zhao, Ling-bin Kong, Yong-chun Luo and Long Kang  
Article first published online: 18 AUG 2011 | DOI: 10.1002/pat.2048

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**A novel acrylonitrile–butadiene–styrene/poly(ethylene glycol) membrane: preparation, characterization, and gas permeation study**

Hamidreza Sanaeepur, Abtin Ebadi Amooghin, Abdolreza Moghadassi, Ali Kargari, Sadegh Moradi and Davood Ghanbari  
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**Effects of hyperbranched prepolymers prepared from butyl acrylate and butyl methacrylate on the electro-optical properties of polymer dispersed liquid crystal**

Zhigang Yang, Ding Li, Cuihong Pan and Yinghan Wang  
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**Research Articles**

**Controlled loading and release of methylene blue from LbL polyurethane/poly(acrylic acid) film**

Chunrui Ding, Shimei Xu, Jide Wang, Yang Liu, Xiaoxia Hu, Peng Chen and Shun Feng  
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**A main-chain phosphorus-containing poly(trimethylene terephthalate) copolyester: synthesis, characterization, and flame retardance**

Hong-Bing Chen, Yi Zhang, Li Chen, Wei Wang, Bin Zhao and Yu-Zhong Wang  
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**Synthesis and characterization of P/Si flame retardant and its application in epoxy systems**

Nianjun Kang, Zhongjie Du, Hangquan Li and Chen Zhang  
Article first published online: 18 AUG 2011 | DOI: 10.1002/pat.2043

[Abstract](#) | [Full Article \(HTML\)](#) | [PDF\(247K\)](#) | [References](#) | [Request Permissions](#)

**Distributed feedback grating fabricated from hybrid polymer precursor gel by employing short-pulse laser interference for photopumped polymer laser applications**

Rahmat Hidayat, Sahrul Hidayat, Fitri Fitrialawati, Herman, May On Tja, Akihiko Fujii and Masanori Ozaki  
Article first published online: 18 AUG 2011 | DOI: 10.1002/pat.2039

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**Morphological comparison of isotactic polypropylene parts prepared by micro-injection molding and conventional injection molding**

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**Homo- and copolymerization of norbornene and 5-norbornene-2-yl acetate with bis-( $\beta$ -ketonaphthylamino)palladium(II)/B(C<sub>6</sub>F<sub>5</sub>)<sub>3</sub> catalytic system**

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Katja Nevalainen, Nora Isomäki, Mari Honkanen, Reija Suihkonen, Tony McNally, Eileen Harkin-Jones, Seppo Syrjälä, Jyrki Vuorinen and Pentti Järvelä

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**Preparation and properties of hollow silica tubes/bismaleimide/diallylbisphenol A composites with improved toughness, dielectric properties, and flame retardancy**

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**Super impact strength of blends prepared from regular HIPS and poly(butyl acrylate)-*block*-poly(styrene) obtained by RAFT polymerization**

Francisco J. Enríquez-Medrano, Martín Hernández-Valdez, Hortensia Maldonado-Textle, Patrick Lacroix-Desmazes and Ramiro Guerrero-Santos

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**Poly (vinyl chloride)/poly ( $\alpha$ -methylstyrene–acrylonitrile)/acrylic resin ternary blends with enhanced toughness and heat resistance**

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Yuan Liu, Qian Xiu, Lifen Xiao, Hui Huang, Lihui Guo, Lirong Zhang, Hailiang Zhang, Songting Tan and Chaofan Zhong

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**Composites of poly( $\epsilon$ -caprolactone) and Mo<sub>6</sub>S<sub>3</sub>I<sub>6</sub> Nanowires**

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**Helical opposition in poly(2-methoxyaniline) doped with beta-cyclodextrin sulfate: electrochemical polymerization and chiroptical properties**

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**Thermal properties and flame retardancy of novel epoxy based on phosphorus-modified Schiff-base**

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**Preparation and properties of Nafion/SiO<sub>2</sub> composite membrane derived via *in situ* sol-gel reaction: size controlling and size effects of SiO<sub>2</sub> nano-particles**

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**Atom transfer radical polymerization with activators regenerated by electron transfer of acrylonitrile from silica nanoparticles, and adsorption properties of the**

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**In situ reactive compatibilization of polypropylene/epoxidized natural rubber blends by electron induced reactive processing: novel in-line mixing technology**

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**Chain extension of adipic acid and (or) succinic acid/butanediol polyesters with 2,2'-(1,4-phenylene)-bis(2-oxazoline) and adipoylbiscaprolactamate combined chain extenders**

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**The impact of resorcinol bis(diphenyl phosphate) and poly(phenylene ether) on flame retardancy of PC/PBT blends**

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**maleimide polymers and fullerene-derivative PCBM**

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**Thermal and dynamic mechanical properties of epoxy resin/poly(urethane-imide)/polyhedral oligomeric silsesquioxane nanocomposites**

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**Radiation effects on styrene–butadiene–ethylene–propylene diene monomer–multiple walled carbon nanotube nanocomposites: vulcanization and characterization**

K. A. Dubey, Y. K. Bhardwaj, C. V. Chaudhari, N. K. Goel, S. Sabharwal, K. Rajkumar and S. K. Chakraborty

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**The effect of electron beam irradiation on dynamic shear rheological behavior of a poly (propylene-co-ethylene) heterophasic copolymer**

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**A biocompatible composite based on poly( $\epsilon$ -caprolactone fumarate) and hydroxyapatite**

Yousef Shafieyan, Shahriar Sharifi, Mohammad Imani, Mohammad Ali Shokrgozar,

Neda Aboudzadeh and Mohammad Atai

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Professor Lifeng Yan, Jing Ji, Songsong Xu and Prakriti R. Bangal

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**Application of hydrophobically modified water-soluble polyacrylamide conjugated with poly(oxyethylene)-co-poly(oxypropylene) surfactant as emulsifier**

Ayman A. Atta, H. I. Al-Shafy and Zakaa M. Mohamed

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**Multifunctional PES fabrics modified with colloidal Ag and TiO<sub>2</sub> nanoparticles**

Darka Mihailović, Zoran Šaponjić, Vesna Vodnik, Branislav Potkonjak, Petar Jovančić,

Jovan M. Nedeljković and Maja Radetić

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**Synthesis and properties of all solid polymer electrolytes based on poly(vinyl acetate-co-acetyl ethylene oxide acrylate)**

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**Synthesis and optical properties of poly (vinyl acetate)/bismuth oxide nanorods**

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**Flammability of carbon nanofiber-clay nanopaper based polymer composites**

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**Flame retardancy mechanisms of poly(1,4-butylene terephthalate) containing microencapsulated ammonium polyphosphate and melamine cyanurate**  
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**Pyrogallic acid-PLGA conjugate as new biodegradable material suitable for final sterilization by irradiation**  
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**Structure and wettability relationship of coelectrospun poly (L-lactic acid)/gelatin composite fibrous mats**  
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**Interpenetrating polymer network hydrogels based on silicone and poly(2-methacryloyloxyethyl phosphorylcholine)**  
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**Dependence of mechanical properties on  $\beta$ -form content and crystalline morphology for  $\beta$ -nucleated isotactic polypropylene**  
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**Effect of polymerically-modified clay structure on the morphology and properties of UV-cured polyurethane acrylate/clay nanocomposites**

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**Synthesis and thermal behavior of a novel UV-curable transparent flame retardant film and phosphorus-nitrogen synergism of flame retardancy**

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**Development of novel synthetic method of carbon nanotubes from electrospun polystyrene fibers by using microwave heating**

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**Studies on the feasibility of recycled polystyrene doped with NLO active *meta*-Nitroaniline for optoelectronics applications**

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**Effects of different types of polyethylene on the morphology and properties of recycled poly(ethylene terephthalate)/polyethylene compatibilized blends**

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**Synthesis and properties of Polycaprolactone-*graft*-poly(2-(dimethylamino)ethyl methacrylate-*co*-methoxy polyethylene glycol monomethacrylate) as non-viral gene vector**

Shutao Guo, Yong Qiao, Weiwei Wang, Jinfeng Xing, Liandong Deng, Anjie Dong and Jianqing Xu  
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**The effect of covalent immobilization of sialic acid on the removal of lipopolysaccharide and reactive oxygen species for polyethylene terephthalate**

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**Preparation and properties of water-absorbent composites of chloroprene rubber, starch, and sodium acrylate**

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**Effect of PEO-PPO-PEO copolymer on the mechanical and thermal properties and morphological behavior of biodegradable poly (L-lactic acid) (PLLA) and poly (butylene succinate-co-L-lactate) (PBSL) blends**

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**Synergistic effect of boron containing substances on flame retardancy and thermal stability of clay containing intumescence polypropylene nanocomposites**

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**Gel strength and swelling of acrylamide-protic acid superabsorbent copolymers**

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**Characterization of polyether-poly(methyl methacrylate)-lithium perchlorate blend electrolytes**

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**Synthesis of waterborne nanopolyaniline latexes and application of nanopolyaniline particles in epoxy paint formulation for smart corrosion resistivity of carbon steel**

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**Effect of blending ratio and oligomer structure on the thermal transitions of stereocomplexes consisting of a D-lactic acid oligomer and poly(L-lactide)**

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**Effect of magnesium dihydroxide nanoparticles on thermal degradation and flame resistance of PMMA nanocomposites**

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**Sulfonated carbon nanotubes/sulfonated poly(ether sulfone ether ketone ketone) composites for polymer electrolyte membranes**

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# Distributed feedback grating fabricated from hybrid polymer precursor gel by employing short-pulse laser interference for photopumped polymer laser applications

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The application of hybrid polymer precursor gel for distributed feedback (DFB) grating laser fabricated by short-pulse laser interference has been investigated. The precursor gel was prepared by sol-gel process from siloxane-modified methacrylate monomer. The molecular structure characterization results show the formation of inorganic networks within the precursor gel, which further undergoes the formation of organic-inorganic polymer network by photopolymerization. The laser interference was performed by using the frequency-tripled output of nanosecond Nd-YAG laser. The fabricated DFB gratings exhibit photopumped lasing actions with high consistency between the grating periodicity (between 380 and 1030 nm) and the lasing wavelength, which appears at the wavelength of the second-order Bragg reflection. The atomic force microscopy measurements clearly show the formation of surface relief (corrugated) structure in those gratings. The mechanism of surface relief formation is attributed to a fast photo-induced swelling process, which is unique property belonging to this kind of hybrid polymer precursor gel. Copyright © 2011 John Wiley & Sons, Ltd.

**Keywords:** sol-gel hybrid polymer; photopolymerization; distributed feedback grating; polymer dye laser; photopumped laser

## INTRODUCTION

Organic-inorganic hybrid polymers based on organo-functional modified siloxanes are very attractive advanced materials because of their unique mechanical and optical properties, which can be modified by the choice of the building molecules and the simplicity of their synthesis processes.<sup>[1]</sup> These polymers have shortly found a wide range of applications, such as protective and functional coatings (anti-reflection and anti-scratch coatings), ceramic powders, nano-matrices for cosmetic and medical products, optical fibers, and waveguides. Commonly also referred as organically modified silicas (ormosils) or organically modified ceramics (ORMOCERS), these hybrid polymers are composed of both inorganic and organic networks. The inorganic network is formed during the sol-gel process as the result of polycondensation of hydrolyzed silicon alkoxide groups. The main difference from the sol-gel product of conventional silicon alkoxide, such as tetraethoxyorthosilicate (TEOS) and tetramethoxyorthosilicate (TMOS), is that the gel product in this case contains polymerizable organic groups, such as methacrylate or epoxy groups. These groups can be polymerized by thermal-polymerization or photopolymerization resulting in the formation of organic network. The polymerization converts the precursor gel into solid polymer featuring a high degree of cross-linked organic-inorganic network connected by strong covalent bonding in the form of a single-phase polymer network.

In the mean time, the utilizations of polymers as host matrices for solid dye lasers and optical amplifier have also received a special attention for a long time. There are a number of reports on the development of dye doped fiber lasers and distributed feedback (DFB) polymer lasers by using, for instance, methacrylic polymers.<sup>[2–5]</sup> In addition, polymers doped with rare-earth complexes have been much investigated also for the same purpose.<sup>[6–8]</sup> Although offering the advantages by the relative ease in its fabrication process, polymer-based optical systems are often faced with the problems related to laser ablation and unfavorable structural change, which is due to high

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