

Third International Conference on Polymer Behavior: “Multiphysics Approaches for the Behavior of Polymers and Polymer-Based Nanomaterials”

MARRAKECH, MOROCCO
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The Third International Conference on Polymer Behavior (ICPB₃) entitled “Multiphysics Approaches for the Behavior of Polymers and Polymer-Based Nanomaterials” was held in Marrakech, Morocco from 3 to 7 November, 2008. It was organized by the Institute of Mechanics of Fluids and Solids Uds/CNRS (France), Semenov Institute of Chemical Physics of the Russian Academy of Sciences (Russia), Pacific Northwest National Laboratory (USA) in cooperation with Al Akhawayn and Cadi Ayyadi Universities (Morocco). This was a regular conference in the chain of meetings started in Moscow on January, 2004 in the framework of the 3rd Kargin Conference “Polymers-2004” and continued in Strasbourg on October, 2006 as the Euromech Colloquium 487 “Structure Sensitive Mechanics of Polymer Materials: Physical and Mechanical Aspects” [1, 2].

The main goal of the meeting in Marrakech consisted in enhancement and stimulation of scientific discussions around the novel trends in multiphysics and multiscale approaches of structure-sensitive mechanics and rheology of modern polymeric materials. The following topics were focused on: (i) thermo-mechanical behavior of polymers and polymer-based nanomaterials; (ii) multiphysics and multiscale approaches (iii) linkage between different length scales; (iv) microstructure sensitive materials design; (v) micro-mechanics and homogenization approaches; (vi) molecular dynamics modeling of structural transformations; (vii) advanced multiscale experimental techniques. There were presented 54 contributions including 1 honorary lecture, 8 plenary lectures, and 45 oral communications as well as posters.

The Conference was opened by Prof. R. Benmokhtar, the President of the Al Akhawayn University (Ifrane, Morocco). He gave a comprehensive review on the state of the scientific research in the Universities of Morocco and the government efforts in the development of the national educational system. The honorary lecture of Prof. E. Oleinik (Moscow, Russia) was devoted to elucidation of molecular mechanisms of development of inelastic deformation of glassy polymers. It was claimed that the key role of this process belongs to the local shear transformations. These mechanically activated anelastic defects were shown to create polymer

conformers contributing to the plastic strain. Interdependence of the molecular strain carriers with dynamic mechanical and dielectric behavior and peculiarities of stress-strain curves of deformed samples was argued. The importance of the anelastic stresses induced under complex deformation processes in mechanical behaviour of PC was corroborated in communication of Dr. C. Dreistadt (Metz, France). Dr. M. Negahban (Lincoln, USA) emphasized that plastically deformed glassy PC shows anisotropic elastic response. He concluded that for capturing this effect one needs to account additional history defining parameters in the stress response function.

A substantial piece of the Conference discussions was given up to different physical and mechanical aspects of semicrystalline polymers. In the plenary lecture of Prof. G. Strobl (Freiburg, Germany) the attention was focused on the laws controlling formation of polymer crystallites. It was argued that kinetics of crystallite growth could be properly interpreted if the intermediate mesomorphic phase between the lateral crystal face and the melt will be taken into consideration. Dr. Z. Bartczak (Lodz, Poland) considered effect of amorphous phase on the high-strain compression of linear polyethylenes of different molecular weights. Radiation cross-linking has been used as an effective tool revealing the role of amorphous phase in the strain hardening as a function of the network density. Dr. L. Chazeau (Lyon, France) presented results on the strain-induced crystallisation of natural rubber filled by carbon black, silica, and silica graft-

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Figure 1:
Participants of ICPB₃.



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ed nanoparticles. It was concluded that effective network density contributed by the chemical crosslinks, entanglements, and filler-rubber interactions is the key parameter controlling crystallization rate. Prof. E. Piorkowska (Lodz, Poland) reported on peculiarities of high pressure crystallization of HDPE droplets surrounded by PS matrix. It was demonstrated that pseudo-hexagonal phase of HDPE arises by means of the heterogeneous nucleation. On the other hand, Mr. F. Spieckermann (Vienna, Austria) presented results on deformation-induced microstructural changes in semicrystalline PP and PHB. Prof. H. Garmestani (Atlanta, USA) paid attention to texture evolution and anisotropic behavior of UHMWPE during uniaxial compression. This methodology was shown to give promising application in improving of properties of the hip implant materials. Presentation of Prof. S. Ahzi (Strasbourg, France) was addressed to modeling of effective elastic properties, yield stress, and large deformation response of semi-crystalline polymers through micromechanically-based approaches. The predicted results were discussed and compared to experimental data.

In his plenary lecture Prof. A. Galeski (Lodz, Poland) presented important observations concerning a source of cavitation in stretched crystalline polymers. Analyzing series of strain rate jumps during high-strain tensile drawing for the native and soaked, in the mixture of low molecular solvents, HDPE and PP. He concluded that cavitation is originated mainly due to free volume dynamic fluctuations of the amorphous phase. Prof. S. Patlazhan (Moscow, Russia) reported on influence of voids to peculiarities of tensile deformation behavior of HDPE below the yield point. It was shown that 2D modeling of the stretched random two-phase system reveals the abnormal butterfly-like structure factor along the elongation direction if the strain-induced microstructure transformations are taken into account. This suggested that SAXS patterns observed recently by Dr. A. Pawlak and Prof. A. Galeski for HDPE and PP are caused mainly by anisotropic distribution of nanovoids. An importance of cavitations in mechanical response of the filled polymer systems was considered in the plenary lecture of Prof. C. G'Sell (Nancy, France) and presentation of Dr. F. Addiego (Esch-sur-Alzette, Luxembourg). Prof. C. G'Sell analyzed mechanisms of deformations of blends consti-

tuted of different amorphous or semi-crystalline polymer matrices reinforced by rigid inorganic particles, rubbery nodules or ductile polymer precipitates. The main outcome of this talk was that cavitation plays a major role in the overall plastic deformation of all systems investigated. Based on the quantified distribution of cavities in the native and filled by CaCO₃ nanoparticles HDPE, Dr. F. Addiego illustrated peculiarities of crazing and particle debonding in these systems. Prof. J-L. Halary (Paris, France) considered in his plenary lecture an influence of cavitation of soft particles on epoxy networks toughening. He showed that efficiency of different inclusions depends on their size, volume fraction, and size distribution. Prof. S. Bazhenov (Moscow, Russia) discussed the remarkable effect of the self-oscillating necking during polymer tension.

The essential aspect of mechanics and physics of polymer-based nanocomposites were presented. In the plenary lecture, Prof. M. Matsuo (Nara, Japan) acquainted with the achievements in preparation of nanocomposites with UHMWPE matrix filled by multi-wall carbon nanotubes or carbon fibers by means of gelation/crystallization method. The electrical and mechanical properties of these materials were considered. Interesting studies of adsorption of PMMA on the aluminum oxide nanoparticles were discussed in the plenary lecture of Prof. R. Tannenbaum (Atlanta, USA and Haifa, Israel). It was shown that the morphology of the interfacial region between the nanoparticles and the adsorbed polymer layer are strongly dependent on the particle size, thickness of the adsorbed layer, and inherent polymer properties. Dr. M. Khaleel (Richland, USA) presented general review of management and research of modern nanocomposite materials conducted in the Pacific Northwest National Laboratory. Dr. S. Nikolov (Düsseldorf, Germany) elucidated multiscale modeling of the elastic properties of the lobster cuticle as the biological polymer-based nanocomposite with hierarchical microstructure. The role of chitin and the multifunctional optimization of the cuticle in terms of trade off between stiffness and transport capacity of the pore channel system was examined. Dr. D. Ruch (Esch-sur-Alzette, Luxembourg) clarified the role of the metal oxide in the thermooxidative degradation of PMMA-based nanocomposites reinforced by TiO₂ nanoparticles. It was found that during

PMMA degradation TiO₂ particles reveal catalytic effect promoting formation of methanol, methacrylic acid, and propanoic acid methyl ester. On the other hand, Prof. A. Marques (Chihuahua, Mexico) has demonstrated that embedding of silver/carbon nanoparticles to PMMA results in increase of the glass-transition temperature.

Essential contributions to multiscale physico-mechanical behavior of polymers and polymer-based nanocomposites were delivered by group of scientists from the University of Luxembourg. The plenary lecture of Prof. J. Krüger was focused on the fundamental issue of validity of the so-called generalized Cauchy relation between the longitudinal and shear moduli. In contrast to the commonly adopted conception that isotropic solids are characterized by two independent elastic moduli, this relation was shown to observe for various materials including visco-elastic and glassy polymers, nanoceramics and polymer-based nanocomposites. The results were obtained by the Brillouin spectroscopy. The same technique was used by Dr. M. Philipp to show that thermal history of the gelation process could result in the set of stable and meta-stable low temperature states of gelatine-based physical gel; Dr. U. Müller studied the interphase formation at the liquid-liquid interface of two reactive components of an epoxy adhesive. The paper of Prof. R. Sanctuary considered the influence of aluminum oxide nanoparticles on the dynamic and isothermal cure of the epoxy resin. By means of optical and thermal investigations Dr. B. Zielinski demonstrated that mixture sequence of two-component epoxy and silicone rubber filled with nanoparticles could result in different properties of nanocomposites.

Structural transformations of anisotropic liquid crystalline solution of HPC filled by natural hydrophilic montmorillonite under flow condition were discussed in the plenary lecture of Prof. V. Kulichikhin (Moscow, Russia). The shear rate depended structural evolution of the mixtures was considered including the unusual change of orientation of the clay particles. Prof. T. Budtova (Sophia-Antipolis, France) presented rheo-optical studies of the shear-induced deformation and break-up of a droplet containing the starch and microgel granules. Finally, Prof. R. Muller (Strasbourg, France) described the technical performance and initial results for a new

mixing device developed from an original concept: the material to be mixed is alternatively pushed from one mixing chamber to another through a flow channel by two reverse pistons. It was revealed that this device exhibits a significantly higher mixing efficiency than rotational laboratory mixers.

In the short report we could not mention all contributions presented in the meeting. Generally, the informal discussions conducted in the Marrakech's Conference were fairly productive and stimulating. The full-scale papers presented in ICPB₃ are going to be published in *Polymer Science, Ser. A* and *Journal of Engineering Materials and Technology*. In the closing ceremony, Prof. A. Galeski has announced that the organizing committee proposed that the Forth International Conference on Polymer Behavior will be held in Lodz (Poland) in 2010.

References

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