Conference Report

DYFP2006, the 13th International Conference on Deformation, Yield and Fracture of Polymers

Rolduc Abbey, Kerkrade, The Netherlands
April 10-13, 2006

Since its start in 1970, the international conference on Deformation, Yield and Fracture of Polymers has been held every three years in Churchill College, Cambridge, UK. Amongst the "mechanical properties of polymers" aficionados these meetings have become known as the "Churchill" conferences, an event that has been established as the leading conference on its subject world wide.

With the intention to renew the programming of the conference and to stimulate the attendance of young scientists, the international scientific committee decided during the twelfth meeting in 2003 to look for a new venue that would bring new life in the conference and would enable a significant reduction in conference organization costs and lodging fees, while keeping the philosophy behind the conference the same. The final choice was the Rolduc Abbey in Kerkrade, the Netherlands. Similar to the previous venue, this abbey offers in-house lodging to all the attendants, and thus offers ample opportunity to meet and discuss with fellow scientists. Given their substantial activity in this field, the Materials Technology Group of Eindhoven University was asked to organize the meeting.

Aerial photograph of the conference center Rolduc in Kerkrade, The Netherlands

Apart from the change in venue, the organizing committee also introduced invited lectures (new for the DYFP conferences) on the following selected themes: ab initio and mesoscale modelling of polymers, thin films and interfaces, gels and bio-applications of polymers, predicting properties of solid polymers, structure development and structure-property relations in semi-crystalline polymers, novel semi-crystalline polymer systems, properties of thermosets, molecular mechanisms of friction, wear and failure, and micro- & nano-indentation.

Apart from these changes, however, the conference was scheduled according to the well-established and successful formula of only plenary lectures combined with ample time for the extended poster sessions (44 lectures, 89 posters and 2 special lectures, the opening lecture by Doros Theodorou and the honorary retirement lecture by Christian G'Sell). The conference welcomed back Ueli Suter and was attended by 177 participants (16 countries, Europe 151, outside Europe 26), a nice international mix of experienced and young faculty, post-doctoral researchers, Ph.D. students, and industrial researchers.

The conference started off with presentations covering the latest developments in ab initio and meso-scale modeling of amorphous polymer systems. Simulations of molecular and atomistic systems reveal that aspects of the mechanical response of disordered materials, like rejuvenation and stress-induced aging, are universal, and arise from the existence of local optima for spatial packing. The phenomena can be captured successfully using an energy landscape framework, where the state of the system is characterized by the ensemble of energy minima visited by the system (Dan Lacks, Case Western). Through the development of new computational approaches, the prediction of physical ageing and plastic deformation of polymer glasses becomes feasible even for time scales and strain rates comparable to those used experimentally (Doros Theodorou, Athens).

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On a macroscopic scale, the ability to predict the deformation and failure response of glassy polymers appears now well established. Following the pioneering work of Mary Boyce at MIT, equivalent methods were developed by Paul Buckley in Oxford and our group in Eindhoven. The latest developments involve a refinement to improve accuracy at high-strain rates (Adam Mulliken, MIT) following the classical rate-approach, an extension to take into account deformation-induced anisotropic flow (Paul Buckley, Oxford), and a new method that enables the prediction of mechanical properties of an amorphous polymer based on the thermal history during processing (Tom Engels, Eindhoven). It was demonstrated that this method quantitatively predicts both short- and long-term failure of polymer products, thus making it a powerful tool for true product optimization.

With respect to semi-crystalline polymers such a quantitative understanding of the structure/property relation is especially complex. It was elegantly demonstrated by Julia Kornfield (Caltech) that for these polymers the crystalline structure (size, orientation) is extremely dependent on (subtle details of) the molecular weight distribution of the polymer and the conditions under which the material is processed. As a consequence, these structural features, and the associated mechanical properties, generally exhibit strong variations throughout even a single processed object, a simple example being the skin-core structures observed in injection moulded products. The practical implications of this were highlighted by Laurent Corté (ESPCI-CNRS, Paris), who addressed the influence of crystalline morphology and orientation on the impact response of toughened PA-12.

A promising method to resolve the complex issue of translating the semi-crystalline microstructure to macroscopic mechanical properties was presented by Hans van Dommelen (Eindhoven). He developed a multi-scale numerical model based on layered two-phase composite inclusions, comprising both a crystalline and an amorphous domain. An aggregate of preferentially oriented composite inclusions, used in a macroscopic finite element model, resulted in good predictions of the orientation dependence of strain-localization phenomena in extruded polyethylene tapes.

The molecular and morphological parameters that govern the abrasive wear of polyethylenes were elucidated by Theo Tervoort (ETH, Zürich). He showed that it is possible to design linear polyethylene grades of molecular weights and molecular weight distributions that show the same wear resistance as UHMW-PE, but simultaneously exhibit the excellent processing properties of high density polyethylene (HDPE).

A novel family of triblock copolymers with syndiotactic and isotactic polypropylene (sPP and iPP) end blocks and ethylene-propylene midblocks was presented by Ed Kramer (Santa Barbara). With their low Young's moduli, large strains at break and excellent elastic recovery they show great potential as thermoplastic elastomers.

Costantino Creton (ESPCI, Paris) addressed the progress that has been made in understanding the molecular features and material properties that control the adhesion of soft materials. An interesting result is the fact that dissipative mechanisms at the molecular level, such as molecular friction, but also network defects or non permanent bonds, significantly enhance the fracture toughness of soft polymer systems. The importance of contact area in adhesion was presented by Alfred Crosby (UMass, Amherst), who demonstrated that through proper coupling of material-defined length scales and the length scales of surface patterns, the adhesion strength can be tuned from 50 % to more than 400 % the value of a non-patterned interface.

The Conference closed with a presentation of Jaap den Toonder (Philips, TU/e) on the current state of the art of instrumented indentation techniques. Recent work on extracting mechanical properties of polymers from indentation experiments shows that linear viscoelastic behavior, post-yield and crazing properties, and size effects can be characterized using a combined experimental-numerical approach.

The next meeting, DYFP2009, chaired by Costantino Creton and Leon Govaert, will be held on April 6 - 9, 2009 in the same venue: Rolduc.

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