Blowing Agents & Foaming Processes
8-9 May 2012
Mövenpick Hotel, Berlin

Timetable

Day One: Tuesday 8 May 2012

08.15 REGISTRATION AND COFFEE

08.45 Welcome and Introduction

Session 1: Blowing Agents and Foaming Processes 2012

09.00 Forty years formulated endothermics in the foamed plastics world

Time is flying or running fast – today the endothermal foaming or nucleating agents are well established in the polymer foam industries. The products themselves went from a speciality into commodity. Many products are in the market place today but the starting line was laid in Germany by Boehringer Ingelheim and forced by customers to produce a ready to use nucleant for mainly PS-directgassing extrusion processes for food trays, thin films for labelling or place mats. Later PE was another target.

After some experience in the above fields the new line was injection moulding due to similar decomposition characteristic temperature wise of the exothermal Azodicarbonamide.

The advantage was: No smell, no discoloration the first product was named Hydrocerol-Compound. The use for application in food packaging, toys and cosmetic/pharmaceutical areas was open. Based on this experience the endothermics made it in most thermoplastic foam application, processes and products. The exothermics can not be replaced but many interesting areas are covered by these products, which coming in age today.

The number of copies, reinventions, modifications and combinations (for example with exothermics) are enormous, but on the other hand all based on the concept of an endothermic "baking powder idea" for plastics.

An overlook of the possibilities and basics will be given.

Dieter Scholz, Scholz Engineering, Germany

09.30 Advancements in high performance blowing agents

This paper will look at the successfully commercialised Solstice™ GBA and the introduction of Solstice™ LBA – high performance, non-flammable blowing agents with property distinction of very low global warming potential, in conformance with the European Union F-Gas Regulation and authorised for EU importation under REACH regulation. Across the spectrum of polyurethane insulation foams and extruded polystyrene insulating foams, the Solstice™ blowing agents platform provide efficacy in energy efficiency, physical properties of the finished insulation product, and adaptation to existing manufacturing processes – affording economics in achieving increasing environmental restrictions globally.

Demonstrated industrial scale application to household refrigerator product and construction applications of sprayed foam insulation and PUR/PIR panel insulation utilising Solstice™ LBA will be outlined. This paper will present comparative data for these blowing agents, including chemical and physical properties, performance and value, and health, safety and environmental considerations. These fourth generation blowing agent molecules promise insulation performance characteristics advantageous to the foamed plastics industry without compromise of finished product specifications, processing parameters, or flammability risk.

Jim M Bowman, Honeywell International, USA

10.00 Blowing agent blends – the new norm

With the cost of each successive generation of physical foam blowing agents climbing ever higher, the world is turning to blowing agent blends for recourse.

Urethanes have long used blends, such as CFC-11/CFC-12 for better solubility and flow properties, or HFC-365mfc/HFC-227ea to mitigate flammability. More recently Hcs [nC5/iC5/cC5] have been blended with one another for improved solubility, flow and thermal properties. These same HCs have been used with HFCs to cut cost, although leading to some flammability issues.

Most recently, DuPont has been investigating azeotropic mixtures of FEA1100 with HCs, methylal, ecomate and certain HFCs. Arkema and Honeywell are following suit.

The purpose of this paper is to show how select blends of ecomate with specific other physical blowing agents can greatly enhance thermal properties, maintain very competitive cost structures, and remain environmentally benign.

John Murphy, Foam Supplies Inc, BMK Corporation, USA

10.30 COFFEE AND NETWORKING

11.00 Performance update of FEA-1100 – a zero ODP and low GWP foam expansion agent

DuPont continues development toward commercialization of FEA-1100 ($CF_3CH=CHCF_3$), a zero ODP (contains NO chlorine) and low GWP foam expansion agent for polyurethane foam applications. FEA-1100 has a unique combination of an excellent environmental profile and desirable foam expansion agent properties, including nonflammability, low vapor thermal conductivity and a boiling point of 33 ^{o}C. The 2011 paper summarized internal testing results, demonstrating FEA-1100 viability as a foam expansion agent for polyurethane foams. This paper will discuss results from both the most recent lab studies and customer evaluations of FEA-1100, including reactivity, physical and chemical stability, insulation performance and other foam properties for various foam applications.

Gary Loh, Joseph A Creazzo & Dr Mark L Robin, DuPont Company, USA

Session 2: Extrusion Direct Gassing Processes and Applications

11.30 Design of experiments in physical foaming and its relation to developments in foam polyolefins

A study was prepared of physical foaming processes on a laboratory scale comprising the variation of parameters such as cell stabilizers, nucleating agents and blowing agents. During these tests different foaming grades were also compared. Via Design of Experiments new models are generated. The models are validated with experiences based on practical foam processes.

John Krist & Emanuel van der Ven, SABIC Technology & Innovation, The Netherlands

12.00 Twin/single tandem laboratory equipment for basic research in foam extrusion

A small-size tandem extrusion line type Schaumtandex ZE30/KE60 has been developed for basic physical foam laboratory testing. The line is composed of a ZE 30 UTX twin screw extruder for melting/mixing and a KE 60 single screw extruder designed for cooling of the melt. The downstream equipment for foam boards includes a wide extrusion die with 150 mm gap and a simplified calibrator/take-off device. The equipment features all technical characteristics of bigger ZE/KE production lines, and even more: the extruder design is suited for standard as well as for high temperature applications up to 350 ^{o}C. This unique machine combination offers state-of-the-art technology to research institutes and R&D centers of foam producing companies.

Matthias Reimker & Otto Deseke, KraussMaffei Berstorff BmbH, Germany

12.30 Q & A SESSION

12.45 LUNCH AND NETWORKING

14.00 Foam-extruded high temperature thermoplastics with different nucleating agents for printed circuit boards

Novel substrate materials for recyclable printed circuit boards (PCB) were developed using a foamed high temperature thermoplastic (polyetherimide, PEI). These innovative printed circuit boards show numerous advantages (eg weight reduction, flame inherent resistance, high frequency-suitable, continuous extrusion processing) compared to conventional employed thermosetting composite substrates.

For the foamed substrates with its technological and economical advantages, it is essential to investigate the influence of different nucleating agents in order to find out how can be achieved the most homogeneous and finest foam morphology. This is especially important for instance to minimize the distance between vias which is a limiting factor for applications that require a very high packaging density.

In this study, different particle sizes and types as nucleating agents for PEI are investigated and their suitability for PCB applications evaluated. First results show a positive influence on the morphology of the polymer foam.

C Keilholz[1], T.Apeldorn[2], F. Wolff-Fabris[1], V. Altstädt[1]

[1]Department of Polymer Engineering, University of Bayreuth, D-95447 Bayreuth, Germany,
[2]Department of Polymer Engineering, University of Bayreuth, D-21107 Hamburg, Germany

14.30 XPS insulation board – new machinery developments

Buildings account for approximately 40% percent of worldwide energy consumption with 50% of average household consumption for space heating and 4% for air conditioning. The insulation of buildings is therefore of huge importance in efforts to reduce energy consumption for the future.

This paper deals with the latest developments in machinery for the production of XPS insulation board. What can be done to make XPS more cost effectively? How can outputs be increased? How can densities be lowered? How can greater thicknesses be achieved with more environmentally friendly blowing agents?

The new machinery concept provides a turnkey solution for producers to manufacture XPS board at low densities using less than 6% by weight of a CO_2 and alcohol gas mixture at very low densities.

Nick King, Sunwell Global Ltd, UK

15.00 Extensional stress-induced foaming behaviours of polysytrene-talc composites

Extensional stresses/strains are often induced on plastic melt in the converging section of a die in extrusion foaming processes, and are retained downstream near the die exit due to the viscoelastic nature of plastic melt. These stresses/strains have significant effects on cell nucleation and growth that ultimately govern the final cell structures and hence their applications. However, thorough understand of their effects have not been achieved. In this context, a novel visualization system has been developed to visually capture the foaming processes under an easily adjustable and uniform extensional strain in a high temperature and pressure environment. Using the foaming of polystyrene-talc composites as case examples, the extensional stress effects on bubble nucleation and growth processes has been investigated with the visualization system in an isolated manner, which has never been achieved previously. It was found that cell nucleating rate and cell density increased significantly as the extensional strain increased. The same phenomena were observed when the extensional strain rate increased. These behaviors could be attributed to the increased supersaturation level as a result of decreased solubility due to polymer chain alignment and reduction in local system pressure as plastic is subjected to an extensional stress.

Anson Wong & Prof Chul B Park, University of Toronto, Canada

15.30 COFFEE AND NETWORKING

Session 3.1: New Aspects, New Foams, Specialities

16.00 Novel polymer foams for sustainable solutions

Cellular polymers are unique materials, as they combine low-weight with outstanding properties in terms of energy absorption, thermal and acoustic insulation performance. As a result, polymer foams are successfully used as sustainable and tailor-made solutions in a multitude of applications. Since their introduction more than 70 years ago, new foams with superior properties have steadily been developed, and their potential still seems far from being tapped. As a key factor, controlling the structure of polymer foams via advanced recipes or novel processing techniques allows to access new properties, providing a pathway to superior products and new applications. In this paper, the activities of polymer research at BASF will be highlighted, and novel products for the packaging, insulation as well as light-weight materials market will be presented.

Holger Ruckdäschel, Peter Gutmann, Christian Däschlein, Roland Hingmann & Klaus Hahn, BASF SE, Germany

16.30 Rheological properties of cellulose acetate with respect to its foamability: influence of plasticizer and blowing agent

Today, oil-based polymers such as polyethylene (PE), polypropylene (PP) or polystyrene (PS) are standard materials for producing extruded foam sheets with physical blowing agents (PBA). Basically, these polymers are a non-biodegradable and based on non-renewable resources. Cellulose acetate (CA), as a cellulose ester, is a biodegradable polymer based on renewable resources. Moreover, CA exhibits excellent optical, mechanical and thermal properties comparable to those of PS. Therefore, CA is a good candidate to replace PS in certain ways. However, pure CA cannot be processed using conventional thermoplastic processing technologies due to the narrow window between its glass transition and decomposition temperature as well as its strong hydrogen bonds between the free hydroxyl groups. Consequently, CA must be modified to achieve thermoplastic properties for foam sheet extrusion. The most common way is the use of low molecular weight plasticizers.
It is well known that the rheological properties such as melt strength are essential for good foaming behaviour of the polymer. Lots of work has been done to investigate the rheology of melts of conventional polymers with respect to their foaming behaviour. The contribution presents recent results of rheological characterization of externally plasticized cellulose acetate. The influence of plasticizer type and plasticizer concentration on rheological properties of cellulose acetate with respect to its foamability was studied. Therefore, rheotens test, die swell test and determination of melt viscosity with rotational rheometer and capillary viscometer were conducted. It was found that an appropriate concentration of plasticizer is necessary to achieve sufficient rheological properties. Furthermore, melt strength, melt elasticity as well as melt viscosity of cellulose acetate can be significantly improved either by using higher concentration of a used plasticizer or by using a more compatible plasticizer type at a constant concentration.

The addition of blowing agents to polymer melts also influences the processing behaviour and rheology of the polymer due to plasticization. As a consequence, melt viscosity of externally plasticized cellulose acetate melts loaded with blowing agents were investigated by means of in-line rheometer.

Stefan Zepnik[1,2], T Hildebrand[3], S Kabasci[1], H-J Radusch[2], F van Lück[4], T Wodke[1]

[1]Fraunhofer Institute for Environmental, Germany
[2]Martin Luther University Halle-Wittenberg, Germany
[3]Institute of Plastics Processing (IKV), RWTH Aachen University, Germany
[4]Inde Plastik Betriebsgesellschaft mbH, Germany

17.00 Applications of optimised IR and laser induced foaming

Rüdiger Wissemborski, Chemische Fabrik Budenheim KG, Germany

17.30 Q & A SESSION

17.45 DRINKS RECEPTION AND NETWORKING

Day Two: Wednesday 9 May 2012

08.00 COFFEE AND HOTEL CHECK-OUT

Session 3.1: New Aspects, New Foams, Specialities (continued)

08.30 Innovative low density silicone RT-foams

Elastomeric silicone foams are extremely versatile materials because they can provide the final user with:

- Benefits of a silicone elastomer (wide temperature range flexibility, good mechanical properties, fire resistance, low smoke generation and low toxic emission, electrical insulating properties)
- Benefits of a foam structure (such as lightweight, damping effects, thermal and acoustic insulation).

Considering that silicone foams have mainly medium density, the development of silicone foams which combine lower density than 0.25g/ml together with good mechanical and fire resistant properties is particularly interesting, especially for transport applications. The challenge in the design of these products is to combine these properties supposed to be antagonistic.

Based on a theoretical modelling study, the aim of this presentation will be:

- firstly, to give an overview of the silicone RTFoam's technology
- secondly, to point out the key role of the balance between the curing and the foaming kinetics
- third, to identify the key parameters that control the density and the bubble growth
- lastly, we will discuss the ways which permitted to fulfil the customer requirements for these elastomeric foams.

As a conclusion, we will present also the performances obtained for the so developed product.

Dr Delphine Blanc, Bluestar Silicones, France

Session 4: Injection Moulding New Findings and Efforts

09.00 Dry ice – physical foam injection moulding the easy way

Currently a new foaming process for injection moulding is in development at the Institute of Plastics Processing (IKV) Aachen, Germany. The idea is to use a volumetric metering of a physical blowing agent in a solid state. The dry ice can be batched with a modified dosing unit. Hence the injection moulding machine does not need to be modified. The blowing agent can be handled in the same way as a colour batch, and so no high pressure occurs.

Daniel Sander & Prof Christian Hopmann, Institute for Plastics Processing IKV), RWTH Aachen University, Germany

09.30 Overmoulding of plane structural foamed parts with a second thermoplastic component

Over the last few years some high efficient manufacturing process in the field of foam injection moulding have occurred because of new developments in the machine, the mould and the material technology. The manufacture of car interior parts with a soft touch surface for example is possible in a one-step injection moulding process, in which an injection moulded carrier is overmoulded with a compatible foamed thermoplastic elastomer (TPE). The TPE-component with compact skin layers and a foamed core generates the soft touch effect, reduces the part weight and observes the quality standards of the automobile manufacturers. Furthermore, this technique offers a much higher economic efficiency compared to conventional manufacturing processes.

To lower the part weight even more, it is hoped that the thermoplastic carrier can be produced in a physical or chemical foam injection moulding process. With special technologies and the right process management it is already possible to foam light plane parts with a high specific flexural stiffness. As the main function of the carrier is the stiffening of the part, an interesting aspect is the impact of the overmoulding process with the TPE-component on the mechanical performance.

This paper will show the possibility to overmould a plane foam injection moulded part with a second thermoplastic component. The aim is to reach ideal dimensional stability and mechanical properties by the right adjustment of the manufacturing process.

Johannes Müller & Volker Altstädt, Neue Materialien Bayreuth GmbH, Germany

10.00 COFFEE AND NETWORKING

10.30 Using mould filling tools for large part, multi-drop parts with the MuCell™ process

Software to predict the polymer flow in moulds for compact parts is standard in the injection moulding industry. However, good predictive tools for microcellular foam moulding have not yet been introduced to the market. However, methods are being developed for adapting the standard mould filling tools for use with microcellular foaming injection moulding. This paper will discuss these methods and the unique focus points for mould filling predictions with microcellular foam injection moulding.

Scott Powers & Levi Kishbaugh Trexel Inc, Wilmington, USA; Uwe Kolshorn & Dr Hartmut Traut, Trexel GmbH, Germany

11.00 Challenges and possibilities in foaming of semi-crystalline poly(butylene terephthalate)

Poly(butylene terephthalate) (PBT) is a technical thermoplastic which is not yet commercially available as foamed material due to the difficulties regarding foamability, characteristic for semi-crystalline thermoplastics. Possible applications of such materials would focus where chemical, heat and abrasion resistance plays a decisive role.

Typically, amorphous thermoplastics have a large foam processing window and the foam morphology can be set by optimising the foaming temperature. In contrast, the partial crystallinity of PBT leads to a narrow processing window around the melting point. A further difficulty is the relatively low melt strength of PBT which can lead to cell coalescence. These difficulties lead to challenges in foaming of PBT and are not fundamentally addressed in literature.

In this study structural PBT foams are processed by foam injection ing and breathing technology. To identify the best foaming conditions the influence of different physical and chemical blowing agents on the density, foam morphology and mechanical performance were investigated. Process parameters like injection speed and breathing were systematically varied to optimise the foaming behaviour. To overcome the problems of low melt strength and cell coalescence some material parameters were changed by adding chain extenders and nucleation agents.

Thomas Köppl, B Fischer & V Altstädt, University of Bayreuth, Germany

11.30 Block copolymer-assisted microcellular supercritical CO_2 foaming of polymers and blends

The behaviour in CO_2 of copolymers containing styrenic, butadiene, and methacrylic or perfluroalkyl blocks is studied (swelling in supercritical CO_2). These block copolymers are considered as neat materials or as additives in blends e.g. in PS or PMMA matrices. In both cases (neat or blend) the copolymers may exhibit a structuration at a micro or nano level. The

phase separated (nano) structures depend on the block content and the concentration of copolymers in the polymer matrix, so that micelles, lamellas, core/shell particles, warm like structures are generated.

When one block is chosen as a highly CO_2-philic moiety, the nanostructures are able to act as CO_2 reservoirs. The result is the possibility to control microcellular foaming, or sometimes nanocellular foaming, of commodity amorphous polymers such as PMMA and PS. Furthermore, at room temperature, the blocks can be either glassy or rubbery in order to freeze the growth and coalescence of cells during foaming.

Different cellular polymers were elaborated by varying either the copolymer type or the foaming conditions (saturation pressure, temperature, depressurization rate, foaming time). For example, cell sizes are accessible in a range from 0.2 to 200 μm, and densities from 0.40 to 1 g/cm^3. Mechanical characteristics will be given. It is shown that structured polymers are also efficient to produce polymer foams with oriented voids. This new approach could be used to produce nanocellular or ultra microcellular polymer foams in a simple process, using blending and extrusion.

Prof Michel Dumon, José Antonio Reglero Ruiz & Eric Cloutet, Université de Bordeaux, France; Javier Pinto Sanz & Miguel Angel Rodriguez Perez, University of Valladolid, Spain; Jean Marc Tallon & Matthieu Pedros, Institut Universitaire de Technologie, Gradignan, France; Philippe Viot, Institut de Mécanique et d'Ingénierie de Bordeaux, France

12.00 Q & A SESSION

12.15 LUNCH AND NETWORKING

Session 5: Biodegradables and Nanostructures

13.30 Tailored uniform foamability and mechanical properties of injection molded polylactide with high void fraction

This paper describes the optimization procedure for the low pressure structural foam molding of linear polylactide (PLA) with high void fraction. The overall structure and foaming behavior of injected samples as well as the corresponding cavity pressure profiles and temperature profiles (using the MPI software) during the injection cycle were investigated at three different sample locations— i.e., near the gate, at the middle, and at the end of the parts. Mechanical properties of the samples were also measured using tensile and impact tests. In order to achieve uniform foaming throughout the sample with good mechanical properties, the optimization procedure investigated the effects of different contents of talc, as the physical nucleating agent, injection flow rate, and melt temperature on the structure, foaming behavior, and mechanical properties of the injected parts. In an attempt to explain the variation of foaming behavior within the sample and also correlate the foaming behavior and resulting

mechanical properties, a mechanism was proposed employing the cavity pressure and temperature profiles.

Aboutaleb Ameli, D Jahani, P U Jung & Prof Chul B Park, University of Toronto, Canada

14.00 Multifunctional nanocomposite foams based on polypropylene with carbon nanofillers

A highly topical subject in polymer foams considers the development of multifunctional materials by combining density reduction with the incorporation of nanosized functional fillers with specific characteristics such as high transport properties. This is the case of carbon-based nanofillers such as carbon nanotubes, nanofibres or graphene. Particularly, graphene, a two-dimensional monolayer of sp^2-hybridized carbon atoms arranged in a honeycomb lattice [1], has attracted a great deal of interest due to its unique characteristics, resulting in exceptional mechanical and transport properties [2-3]. One of the most promising applications of graphene is as filler in polymer nanocomposites [4], as it has been shown that these may display significant property improvements at much lower filler concentrations when compared to microsized-filled polymers.

We have previously shown that the incorporation of carbon nanofibres to polypropylene and later foaming resulted in foams with finer cellular structures and higher specific mechanical properties [5]. Most importantly, typical electrical conduction behaviour was observed for the foams at lower nanofibre concentrations than the solids [6]. This presentation covers our most recent results regarding the preparation and characterization of rigid polypropylene composite foams filled with graphene and carbon nanofibres, with the main goal of developing new multifunctional lightweight materials with improved transport properties.

[1] Singh, V., Joung, D., Zhai, L., Das, S., Khondaker, S.I., and Seal, S., Prog. Mater. Sci. 2011, 56, 1178.
[2] Zhu, Y., Murali, S., Cai, W., Li, X., Suk, J.W., Potts, J.R., and Ruoff, R.S., Adv. Mater. 2010, 22, 3906.
[3] Geim, A.K. and Novoselov, K.S., Nat. Mater. 2007, 6, 183.
[4] Potts, J.R., Dreyer, D.R., Bielawski, C.W., and Ruoff, R.S., Polymer 2011, 52, 5.
[5] Antunes, M., Velasco, J.I., Realinho, V., and Arencón, D., J. Nanosci. Nanotech. 2010, 10, 1241.
[6] Antunes, M., Mudarra, M., and Velasco, J.I., Carbon 2011, 49, 708.

Dr Marcelo Antunes, Gabriel Gedler, Miguel Mudarra & José Ignacio Velasco, Universitat Politècnica de Catalunya, Spain

Session 6: News from Research and Development Activities

14.30 Reinforced particle foams

There is a high potential for polymeric foams in applications with advanced mechanical requirements like structural lightweight parts for energy absorption. To fulfill the requirements of a high energy absorbance foamed parts with tailored properties (reinforcements), efficient processing behavior and flexibility to complex product geometries are obligatory. In this paper innovative technologies, improving the compressive strength for high energy absorbance applications will be discussed, whereby two novel processing methods for reinforcing particle foams will be introduced.

The first method highlighted is the processing of particle foams using Carbon Nano Tubes (CNT) in a continuous extrusion line in combination with an underwater pelletizing process. Results concerning foaming behavior in the extrusion process as well as the part manufacturing in steam chest molding will be demonstrated. Furthermore some achieved properties of the foamed particles and foamed parts will be discussed.

In the second process shown, the recent progress by Fraunhofer in developing an innovative concept for creating hybrid particle foams combining polymer- and metal based foams will be described. Results presented in the area of technology development focus on the progress made in the development of the mould filling technology with particulated foams. Effects on the crash absorbing behavior by varying will be discussed.

Florian Rapp, Dr Axel Kauffmann & Dr Jan Diemert, Fraunhofer Institute for Chemical Technology ICT, Germany

15.00 COFFEE AND NETWORKING

15.30 Density graded polyethylene foams produced by compression moulding using a chemical blowing agent

Density graded polyethylene foams were produced using a chemical blowing agent and compression ing. To control the local density inside the foams, the top and bottom plates of a compression ing set-up were placed at different temperatures and ing times in order to produce symmetric and asymmetric structural foams. Due to the different temperature gradients produced inside the samples, complex density profiles were created. From the samples obtained, a complete morphological analysis was performed to extract cell size and cell density across foam thickness in relation with the density profiles. Also, to determine the effect of the density profile on the mechanical properties, tensile and flexural characterizations were done and discussed in relation with optimum properties vs. bulk foam density.

Jiaolian Yao & Denis Rodrigue, Université Laval, Canada

16.00 Improving XPS insulation boards and new insulation products

The world´s insulation market is split into about 40% rock wool, 30% EPS, 10% Polyurethane, 3% XPS and a variety of other products. EPS is gaining an increasing market share, as with the development of the BASF Neopor black foam, the insulation properties could be improved significantly by dropping the lambda value from 40 to 30 mW/m²K. The best insulation properties of the common products still has Polyurethane with down to 22 mW/m²K. Rock wool has been losing market share, as the lowest lambda values, that could be achieved, could not be significantly reduced below 40 mW/m²K. XPS insulation properties increased when the 2nd generation of air conditioning gasses was banned: the CO_2 blown boards reach a lowest of 30 mW/m²K. With the 4th generation of air conditioning gasses XPS reaches (2011) a lowest lambda value of 27 mW/m²K.

The first part of the paper deals with a new concept of decreasing lambda value of XPS insulation boards and in the second part of the paper, a new insulation board is presented, that, based on sticking foam sheets together, can be made with EPS-like densities but with much lower lambda value.

Frank van Lück, AIXtrusion Consulting, Germany

16.30 High melt strength polypropylene for foaming

Polypropylene (PP) foam has become the new favourite in the field of foaming in the 21st Century due to its wonderful mechanical properties and heat resistance, its reclaimable and degradable properties. The prospect of PP foam's application is very tempting. However, the traditional PP can not realise an effective foaming due to its poor melt strength and strong crystalline performance. It is the most pivotal technology to research for a simple, low cost and effective method of preparing high melt strength polypropylene (HMSPP). This paper summarises the properties and applications of HMSPP and the preparation methods and technical difficulties are introduced. The presentation emphasizes the review of the preparation methods including directional polymerization, gamma irradiation, reactive extrusion and blending methods. The research, development and application of HMSPP are introduced all over the world. Finally, the developing tendency and solution of HMSPP is pointed out, as well as a novel HMSPP.

Dr Peng Guo, Prof Mingfu Lv & Prof Dr Shijun Zhang, Beijing Research Institute of Chemical Industry, SINOPEC, China

17.00 Q & A SESSION

17.15 CLOSE OF PROCEEDINGS

For further information please contact:
Helen Charlesworth, Smithers Rapra Technology Ltd, Shawbury, Shropshire, SY4 4NR, UK
Direct Tel: +44 (0)1242 694372, Switchboard: +44 (0)1939 250383, Fax: +44 (0)1939 251118
Email: hcharlesworth@ismithers.net