Gas-Assisted Injection Molding Technology

By Yijie Wang (Koelling)

Gas assisted injection molding is a new polymer processing technique that is capable of producing hollow sections in plastic parts. To obtain a product with the desired property, it is necessary to predict and control the size and location of the penetrating gas bubble. Work has been done to study the effect of temperature gradients on gas bubble size, along with how part thickness and polymer rheology affect the fingering instability that often occurs in the gas-assist process. To understand these mechanisms better we are studying the non-isothermal injection process of polymers and developing a theoretical explanation of the fingering instability. This information can be incorporated into existing commercial simulation software to better predict gas bubble size and location.

SMC Compression Molding and In-Mold Coating Simulation

By Lisa Abrams and Suneel Vadlamudi (Castro)

Research is underway to understand and quantify both the effect of substrate (SMC) compressibility on the flow of in-mold coating, and the effect of SMC paste rheology on the flow of SMC. The extension of in-mold coatings to thermoplastic substrates is also being pursued. This project makes extensive use of the equiment donated by GenCorp.

PVC Degradation during Injection Molding

By Jose Garcia (Koelling)

The degradation of PVC during injection molding was computed for two different geometries: flow in a rectangular channel and radial flow. Although simple, these two geometries represent commonly encountered flow patterns in injection molding applications. In addition, working with the simpler geometries allows for an increased level of detail in the thickness direction, vital for computing the degradation.

Recent work has been dedicated to the development and experimental verification of the radial flow model. Similar to the work performed with the flow in a rectangular channel, a computational tracer method combined with a finite difference scheme is being used to predict the degree of degradation for different flow conditions. Preliminary results indicate some differences in the computed levels of degradation between the two geometries.

Compounding and Processing of Nanocomposites

By Hua Wang and Changchun Zeng (Lee, Koelling, and Tomasko)

Our extrusion results showed that nanoclay is an effective ‘mixing aid’ in thermoplastic polymer blending. We are currently investigating the mechanism of mixing and dispersion of polymer blends containing nano-particles. Other on-going research tasks include (a) using supercritical CO2 to facilitate exfoliation of nanoclays in polymer melts, (b) investigating the dispersion and processing of nanoclays in thermoset polymers and how nano-particles affect the mechanical and thermal properties of long fiber reinforced composites, and (c) studying the feasibility of using nanocomposites as dental materials.

Elimination of Flow Marks During Injection Molding

By Guojun Xu (Koelling)

Injection molding is sometimes accompanied by the appearance of flow marks. Tiger striping is a type of surface defect in injection molding which shows alternating dull and glossy surfaces. The objective of this research is to study the occurrence of flow marks and understand how to eliminate them. The effects of injection speed, mold geometry, melt and mold temperature, lubricant, and melt rheology are being studied. Initial results with TPO resins show that the most important factor affecting the occurrence of flow marks is injection speed. Tiger striping did not occur at high injection speeds in a spiral mold. There exists a critical shear stress, above which the tiger striping was eliminated. The addition of lubricants, which lowers the shear stress experienced by polymer melt, reduced the flow marks.

Production of Continuous Microcellular Foam

By Xiangmin Han (Koelling, Tomasko, Lee)

To process microcellular foam, it is important to obtain solubility of carbon dioxide in the polymer melt. Based on experimental data, the Sanchez-Lacombe model was applied to predict how much CO_2 can be dissolved in polystyrene at a given temperature and pressure. Another key point for microcellular foam processing is the design of the extrusion die. Currently in our lab,foam extrusion can be performed under a steady state by using a larger die (D=1.2mm, L=24mm). The cell size under this condition was found to be around 150 microns. A new extrusion die with a diameter of 0.5mm and a length of 10mm is being manufactured. This die will produce a pressure drop of more than 4000 psi and a pressure drop rate with a magnitude of 10^9 Pa/sec, which will reduce cell size and increase cell density.

Analysis of De-Airing Process in Automobile Windshield Manufacturing

By Yi-Je Juang and Denitra Bruer (Lee and Koelling)

Material behavior in the de-airing process can be analyzed and understood through extensive rheological experiments. These experiments establish the relationship between material properties, processing conditions, and pre-press quality. In the de-airing process, the polymer is processed near the glass transition temperature in a way similar to other polymer manufacturing operations such as plastic welding, thermoforming, blow molding, forging, etc. Strain hardening and yield stress may play an important role, causing flow behavior to differ substantially from that of a polymer melt. To understand the flow behavior near the glass transition temperature, rheological properties were characterized through transient shear viscosity measurement, tensile and compression tests. The measured flow properties were modeled by both viscoplastic models and by the power law. The finite element code *DEFORM* was applied to compare simulation and experimental results. Preliminary results showed that the rheological behavior of polyvinyl butyral materials are described better by viscoplastic models than by the power law. ■