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THE DEVELOPMENT OF A VISUALIZATION SYSTEM TO OBSERVE PLASTIC FOAMING PROCESSES UNDER SHEAR STRESSES

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Molten plastics are often subjected to shear stresses within plastic foam processing equipments when foaming occurs, such as near the die exit of a foam extrusion system. Meanwhile, previous researches have shown that shear stresses affect cell nucleation and growth in plastic foaming processes, which ultimately govern the cell morphology of plastic foams products, and hence the products' mechanical, thermal, acoustical, and/or optical properties. Therefore, it is critical to investigate the fundamental mechanisms of shear-induced cell nucleation and growth. Despite many valuable insights offered by pioneers in this subject, firm understanding has not been established due to a lack of clear empirical data. In particular, while in-line observations of extrusion foaming and injection foam molding processes provide useful cell formation and growth data, a controllable shear stress field cannot be easily induced in a plastic sample to evaluate its effect. Several other pioneers developed foaming systems to produce plastic foams under controllable shear strains and shear strain rates in batch processes, but the foaming processes could not be observed in those cases and the characterization of cell morphology were conducted afterward. Therefore, the shear effect on cell nucleation and growth could not be investigated thoroughly. In this context, this paper presents the development of a novel visualization system to observe and capture plastic foaming processes under controllable shear strain/shear strain rate in a batch process. This system is highly versatile and allows for easy adjustment of critical experimental parameters: plastic material, foaming agent, system temperature, pressure, pressure drop rate, shear strain and shear strain rate. Plastic foaming experiments of polystyrene blown with carbon dioxide were carried out to demonstrate the capability of the system, as well as to investigate, as a preliminary study, the effect of shear stresses on cell formation behaviors based on the in situ foaming videos.