Rheological behavior and foam morphology of linear and modified ETFEs

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Abstract. We studied the modification of rheological behavior and foam morphology of alternating ethylene-tetrafluoroethylene copolymer (ETFE). ETFE copolymerized with vinyl compound showed high G' and G" at low angular frequencies, while the linear ETFE showed terminal relaxation behavior as well as other linear flexible polymers. Although linear ETFE indicated the strain rate independent elongational behavior, the modified ETFE showed the strong deviation of elongational viscosity from linear viscoelastic regime. We will also report the change of the foam morphology of the modified ETFE.

Keywords: ETFE, fluoropolymer, rheology, dynamic viscoelasticity, elongational viscosity.
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INTRODUCTION

Ethylene-tetrafluoroethylene copolymer (ETFE) is widely used in many fields such as automobile, modern construction, airplane, solar battery panel areas due to the high chemical and thermal resistant, flame retardancy, weathering, an electric insulation properties. Therefore ETFE is intensively explored on the mol e cul a r pa r ame te r s , microstructures, crystallization behaviors, flow behaviors under steady shear, flow instabilities. However, ETFE is one of typical linear polymers and the improvement of the rheological behavior by introducing the long chain branch has not been reported.

Now more advanced control of rheological behavior of ETFE is required for the wider applications and precise processings in which ETFE has not be utilized owing to the limited rheological properties so far. In this paper we tried to introduce the long chain branch into ETFE and the shear and elongational flow behaviors are reported. Furthermore, we will report the batch foaming behaviors of neat ETFE and the modified ETFE.

EXPERIMENTAL

We used conventional ETFE (C88AX, Asahi Glass Co., LTD, Japan) and ETFE copolymerized with divinyl compound, which is indicated as ETFE-B. ETFE-B of weight percentages of 5, 10 and 30 was blended with ETFE by twin-screw extruder, indicated by notations of ETFE5, 10, 30, respectively.

RESULTS AND DISCUSSION

ETFE-B synthesized with divinyl compound showed much elastic viscoelastic behavior in low frequency range, which neat ETFE indicated terminal flow behavior. Within the measured frequency for ETFE-B G' was always higher than G". G' is parallel to G" at high frequency and the slope of G' leveled off with decreasing with frequency. This means an existence of very long time relaxation component. By blending ETFE-B with ETFE G' of the blends at low frequency increased with increasing the weight ratio of ETFE-B. This is due to introduction of long relaxation time component of ETFE-B which dispersed in ETFE. We carried out the elongational viscosity measurement. Linear ETFE mere showed smooth increase of elongational viscosity. The curves were independent of strain rate and merged into one curve. The elongational viscosity of ETFE blended with ETFE-B exhibited steep increase at a certain time, depended on the strain rate.

We carried out batch-foaming by using CO_2 as a foaming agent. ETFE blended with ETFE-B showed the smaller cell size and higher cell number density comparing with those of ETFE.