Development of Ripplon Scanning Technique for Surface Viscoelasticity of Polymer Solutions

T. Ueno[C,S] and Y. Nagasaka
Department of System Design Engineering, Keio University, Yokohama, Japan
ueno@naga.sd.keio.ac.jp

In the membrane and coating industries, the quality of the membrane products depends on micro or nano scale morphology, which is governed by surface properties such as surface tension and viscosity. It is therefore important to observe these surface properties during the membrane manufacturing process. However, the widely used conventional contact methods are unsuitable for the above mentioned process. The purpose of the present study is to observe the behavior of surface phenomena during the membrane manufacturing process by the surface laser-light scattering (SLLS) method.

The SLLS method, which can measure the surface tension and viscosity simultaneously, has been developed using a thermal capillary wave (ripplon). The features of this measurement system are as follows: (1) high-speed (maximum 1 measurement/s) surface phenomena can be observed dynamically; (2) 2-dimensional surface tension and viscosity can be observed by scanning the SLLS system horizontally to the sample; and (3) non-contact and in situ measurements can be carried out.

In the present study, we measured the surface tension and viscosity of CAB (cellulose acetate butyrate) and oil soluble surfactant solutions in MEK (methylethyl ketone), which were used in actual film manufacturing processes, under a controlled temperature. When we compared the measured results of the SLLS method with those of the contact method, a 10 ~ 30 % lower surface tension was obtained, under various oil soluble surfactant concentrations. The predicted difference between the SLLS method and the contact method is that the propagation of ripplon was greatly affected by the adsorption of the CAB or surfactant on the liquid surface. Thus, a viscoelastic dispersion equation in the presence of a monolayer film was established. As a result, the viscoelasticity dependence on solute concentration of CAB solution in MEK was calculated for the first time.