Formulation of Transparent O/I$_1$ and O/H$_1$ Emulsions in Nonionic Surfactant Systems

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Liquid crystalline phases such as cubic phase and hexagonal phase have viscoelastic properties so that we can obtain a gel-like emulsion by employing such a liquid crystal as a continuous phase. In this contribution formulation of O/I$_1$ and O/H$_1$-type emulsion and how to adjust the transparency of the emulsions are presented. The O/I$_1$ and O/H$_1$-type emulsions can be obtained from equilibrium of a cubic phase and a hexagonal phase with excess oil phase, respectively, by dispersing the oil phase in the liquid crystalline phases as particles. Since such liquid crystalline phases are viscous, emulsification is performed at a temperature being higher than the melting temperatures of the liquid crystals. Once the oil phase is well-dispersed, the system can be cooled down which makes the continuous phase turns again into a liquid crystalline phase. Rheological properties of the O/I$_1$ and O/H$_1$-type emulsions are solid-like one and highly viscous. Like convensional O/W-type emulsions, the O/I$_1$ and O/H$_1$-type emulsions are milky appearance but one can obtain a transparent emulsion at a certain composition due to the contrast matching of the dispersed and the continuous phases [1].

More active approach to obtain the transparent O/I$_1$ and O/H$_1$-type emulsions is to adjust the refractive index of the aqueous phase by mixing a high-refractive index solvent such as glycerol. Fig.1 is the change in the transparency of the O/I$_1$-type emulsion formed in a water/glycerol/C$_{12}$EO$_9$/isododecane system. The glycerol concentrations in a water-glycerol mixture are shown. The transparecy is varied gradually and a transparent emulsion is formulated at 40wt% of glycerol. When we changed the surfactant to C$_{12}$EO$_7$, the transparent emulsion cannot be obtained since the phase transition takes place at high glycerol concentration. A transparent O/H$_1$-type emulsion can also be obtained by adjusting the refractive index of the continuous phase.

<table>
<thead>
<tr>
<th>0wt%</th>
<th>10wt%</th>
<th>20wt%</th>
<th>30wt%</th>
<th>40wt%</th>
<th>50wt%</th>
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Fig.1 Adjusting transparency of O/I$_1$ emulsion by glycerol concentration in aqueous phase.