Studies on Interfacial Films of 1H-Perfluorodecane at Oil/Water and Oil/Air Interfaces

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The interfacial films of 1H-perfluorodecane (HCF$_2$(CF$_2$)$_7$CF$_3$; HFC$_{10}$), which has the terminal dipole generated by the electronegative nature of fluorine atom, at the oil/water and oil/air interfaces were investigated in order to clarify the effect of terminal dipole on the state of interfacial films by the interfacial tension measurement and thermodynamic data analysis. The interfacial tensions $\gamma$ of the hexane solution of HFC$_{10}$ against water and air were measured as a function of the molality $m_1$ at 298.15K and that of the liquid HFC$_{10}$ against water was measured as a function of the temperature $T$ under atmospheric pressure. It was revealed that HFC$_{10}$ shows negative adsorption at the hexane solution/water interface and positive adsorption at the solution/air interface. These results are mainly due to the fact that the interfacial tension against water is larger for fluorocarbon (FC) than for hydrocarbon (HC), while that against air is smaller for FC than for HC. The $\gamma$ value of the liquid HFC$_{10}$/water interface increases with increasing $T$ and the $\gamma$ vs. $T$ curve shows a break point corresponding to the phase transition in the interfacial film. Below the break point, the entropy of interface formation is negative, suggesting that terminal dipoles of HFC$_{10}$ can interact effectively with water to form adsorbed film.

The effect of adsorption of HFC$_{10}$ on the state of interfacial films was further examined in the mixed adsorption of HFC$_{10}$ and 1H,1H,2H,2H-perfluorododecanol (CF$_3$(CF$_2$)$_7$(CH$_2$)$_2$OH; FC$_{12}$OH) at the hexane/water interface. The interfacial tension $\gamma$ of the hexane solution of HFC$_{10}$ and TFC$_{12}$OH mixture against water was measured as a function of the total molality $m$ and the bulk composition of HFC$_{10}$ $X_2$ at 298.15K under atmospheric pressure. The $\gamma$ vs. $m$ curve of pure FC$_{12}$OH system shows a break at low $m$ due to the gaseous – condensed phase transition. In case of mixed system, another break (second break) appeared on the curve at high $m$ close to solubility limit. Judging from the interfacial density and interfacial pressure vs. mean area per molecule curve, it was concluded that the molecules pile spontaneously and form multilayer above the second phase transition. The phase diagram of adsorption suggested that the mixing of a trace amount of HFC$_{10}$ with FC$_{12}$OH in the condensed monolayer induces piling molecular by dipole-dipole and dispersion interactions to form multilayer.