Aggregation behavior and thickening ability of nonionic low molecular amphiphiles having CO_2-philic trimethylsilyl and CO_2-phobic hydrocarbon groups in supercritical CO_2

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Enhanced oil recovery technology using CO_2 (CO_2-EOR) has been not efficient so far due to very low viscosity of CO_2 compared with crude oils. To overcome this issue, enhancement of CO_2 viscosity has been tried with fluorinated thickeners being expensive and environmental burdensome. Aiming to develop an efficient fluorine-free CO_2-thickener, this study synthesized polymers and amphiphiles having CO_2-philic trimethylsilyl (TMS) groups and examined their CO_2-thickening ability by the EMS viscometer and formation of shape-anisotropic aggregates by SANS technique. These results suggested amphiphiles having two TMS groups to form ellipsoidal aggregates at various temperatures and 300 bar condition(Table 1).

Keywords : Supercritical CO2, Molecule Assembly, Nonionic Amphiphile, Thickener

CO_2 を用いた原油増進回収法（CO_2-EOR）は、CO_2 の粘度が原油に比べて、非常に低いため、効率が悪い。この問題の解決のため、高価で環境毒性の高い、フッ素系の増粘剤による CO_2 の増粘が試みられてきた。本研究では、フッ素フリーの効率的な CO_2 増粘剤の開発を目指し、親 CO_2 性トリメチルシリル基（TMS）を有する両親媒性物質とポリマーを合成し、EMS 型粘度計により CO_2 の増粘効果と SANS 測定により形状異方性分子集合体の形成について検討した。解析の結果、TMS を 2 つ持つ両親媒性物質が、300bar 条件の様々な温度で楕円体状の分子集合体を形成することが示された（Table 1）。

Table 1 Shape parameters* obtained by SANS data and fitting curves for the 50 mM TMS2AH8/CO_2 mixture at various temperature and pressure conditions. Specific viscosity was estimated from the shape parameters.

Temp. / °C	Press. / bar	$R_{f\text{-}sph}$ / Å	$R_{f\text{-}eq}$ / Å	$R_{f\text{-}pol}$ / Å	Aspect Ratio	Specific viscosity
55	300		18.20	163.33	9.0	1.30
75	300		17.34	170.42	9.8	1.30
75	200	18.5				

* $R_{f\text{-}sph}$ is radius of spherical aggregates, $R_{f\text{-}eq}$ and $R_{f\text{-}pol}$ is equatorial and polar radius of ellipsoidal aggregates, respectively.