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Supporting Information

Aggregation Behaviour of E-SARA Asphaltene Fractions Studied by Small-angle Neutron Scattering

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A1. Scattering Length Density.

Due to the complex mixtures of structures an exact value for the scattering length density (SLD) of asphaltenes cannot be accurately calculated. As the coherent scattering from a sample is directly proportional to the square of the difference in SLD between the sample and solvent, this approach can be used to determine the average SLD of asphaltenes.

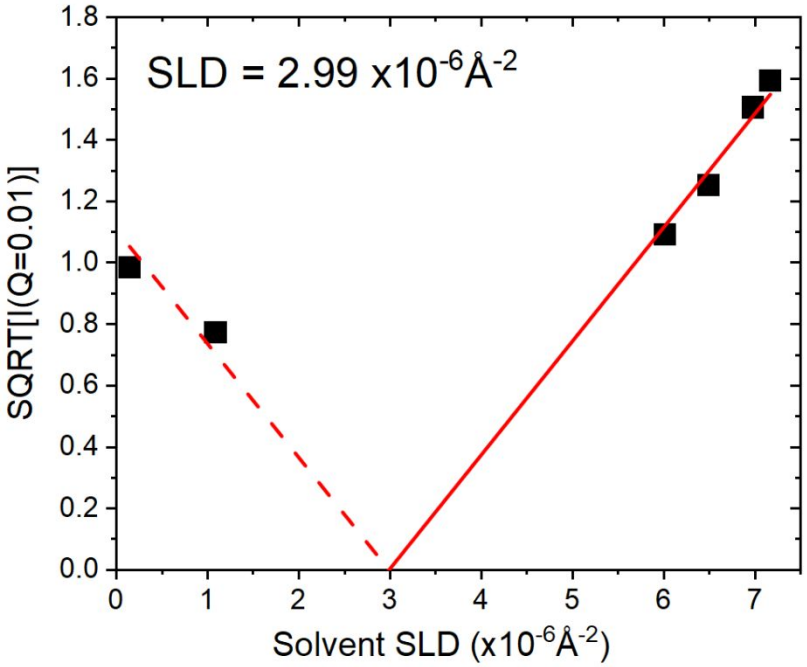

Figure S1. Average SLD of WA extracted from heavy crude oil.

The average scattering intensity at Q = 0.01 cm^{-1} for 5 g/L WA in mixtures of deuterated and hydrogenated toluene, 1:1 heptol and 3:2 heptol is shown in Fig. S1. A Q value of 0.01 cm^{-1} was chosen as a compromise between minimizing the Q value and maximizing the number of data points to give an accurate fit over the Q range $0.001 \leq Q \leq 0.50$ $Å^{-1}$. A line of best fit through all data points is shown. The slope of both lines is equivalent (-ve and +ve) and intersects at $2.99 \times 10^{-6} Å^{-2}$.

A2. Calculating nanoaggregate volume (WA heavy crude oil).

$I(0) = 0.65$ and $I(0) \approx \Phi V \Delta\rho^2$

$$0.65\ (cm^{-1}) \approx 0.005 \times V \times (5.66 \times 10^{-6} - 3 \times 10^{-6})^2 (Å^{-2})^2$$

$$0.65 \times 10^{-8}\ (Å^{-1}) \approx 0.005 \times V \times 7.0756 \times 10^{-12}\ (Å^{-4})$$

$$V \approx \frac{0.65 \times 10^{-8}\ (Å^{-1})}{0.005 \times 7.0756 \times 10^{-12}\ (Å^{-4})}$$

$V \approx 183730\ Å^3 \approx 184\ nm^3$ (radius of equivalent sphere ~ 3.5 nm)

A3. 1 g/L WA in d-toluene SANS.

The scattering intensity for 1 g/L WA in d-toluene is shown in Fig. S2. The Broad Peak model fitting parameters are provided in Table S1.

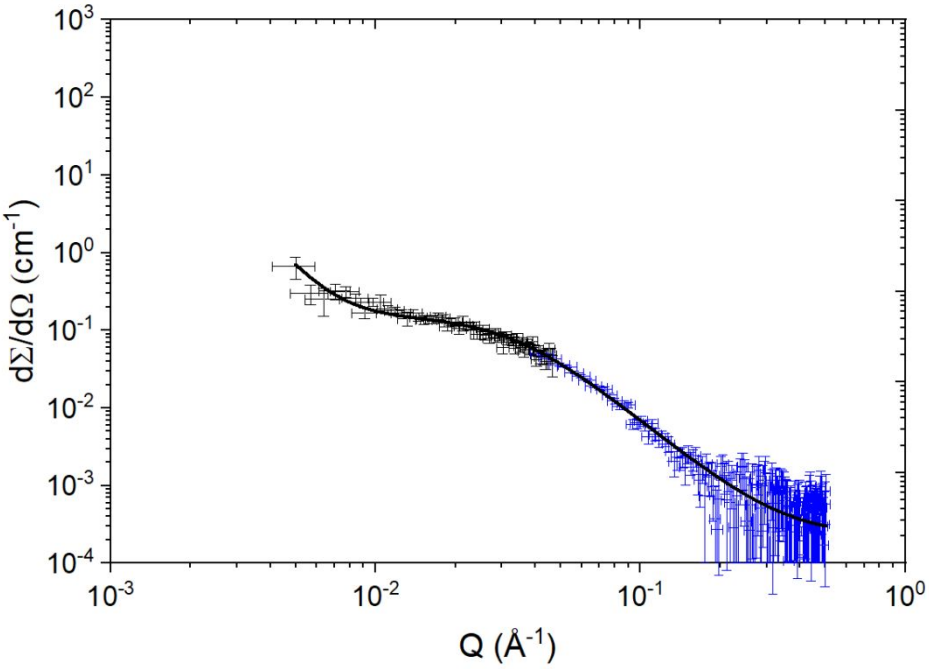

Figure S2. SANS spectra of 1 g/L WA in d-toluene extracted from bitumen. The solid line represents the Broad Peak model fit.

Table S1. Fitting parameters of the Broad Peak model to the SANS profile of 1 g/L WA in d-toluene extracted from bitumen.

Sample	Fitting parameters					
	χ^2	Background (cm^{-1})	Porod scale	Lorentz scale (cm^{-1})	Characteristic length (Å)	Lorentzian exponent
Bitumen WA 1 g/L	0.72	0.0002	1.58×10^{-8} $\pm5.56\times10^{-11}$	0.15 ± 0.01	29.9 ± 0.9	2.79 ± 0.06

A4. Asphaltene precipitation in 3:2 d-heptol.

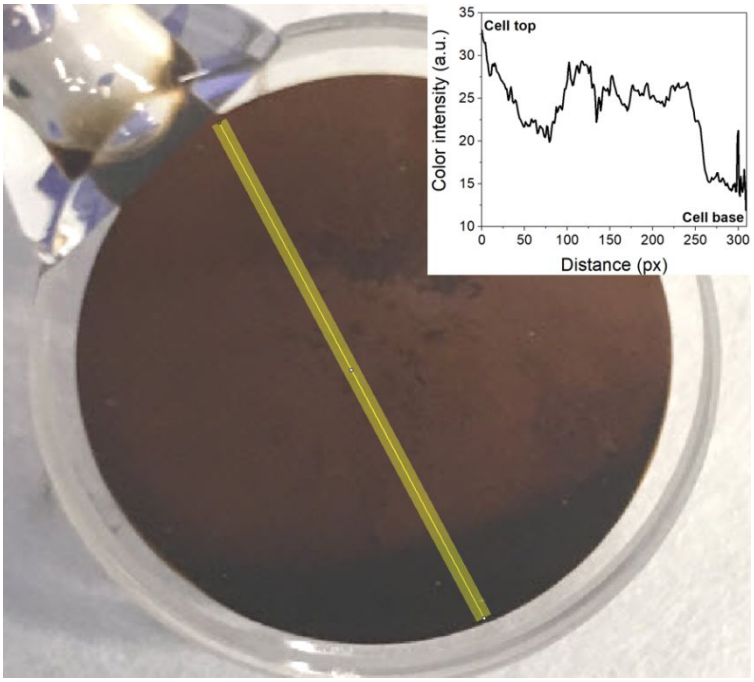

Figure S3. Image of SANS cylindrical quartz cell of 5 g/L WA in 3:2 d-heptol after a 6 h test. A small accumulation of precipitated asphaltenes was observed at the cell base. This is confirmed by the changing color intensity along the highlighted line in the main image. Low color intensity (15 a.u.) corresponds to region of precipitated asphaltenes.