Electronic Supplementary Material (ESI) for Soft Matter.

Electronic Supplementary Information

Towards optimised drug delivery: structure and composition of testosterone enanthate in sodium dodecyl sulfate monolayers

Yussif Saaka, Daniel T. Allen, Yuvared Luangwitchajaroen, Yanan Shao, Richard A. Campbell, Christian D. Lorenz, and M. Jayne Lawrence

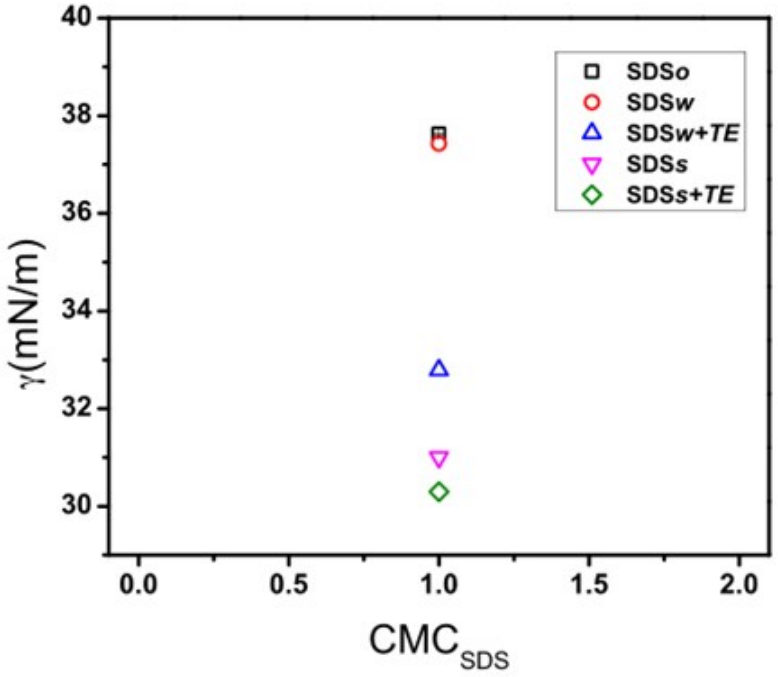

Figure SI1: Variation in surface tension (γ) at the critical micelle concentration (CMC_{SDS}) of SDS at the air-water interface at a temperature, T = 298 $\pm$ 0.1K for TE-free SDS (SDSo), SDS in TE-saturated water (SDSw), SDS in the presence of saturation amounts of TE (SDSs) and with additional TE spread on the surface of SDS in TE-saturated water (SDSw+TE) and in the presence of saturation amounts of TE (SDSs+TE).

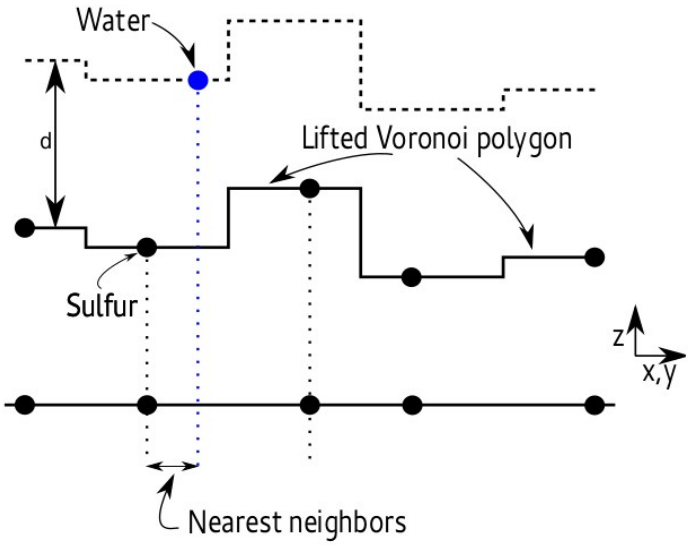

Figure SI2: A schematic drawing of the algorithm used to determine the 'intrinsic surface' of the SDS monolayer from the molecular dynamics trajectories. This approach takes into account the roughness of the interface and therefore more accurately represents the local location of the interface.

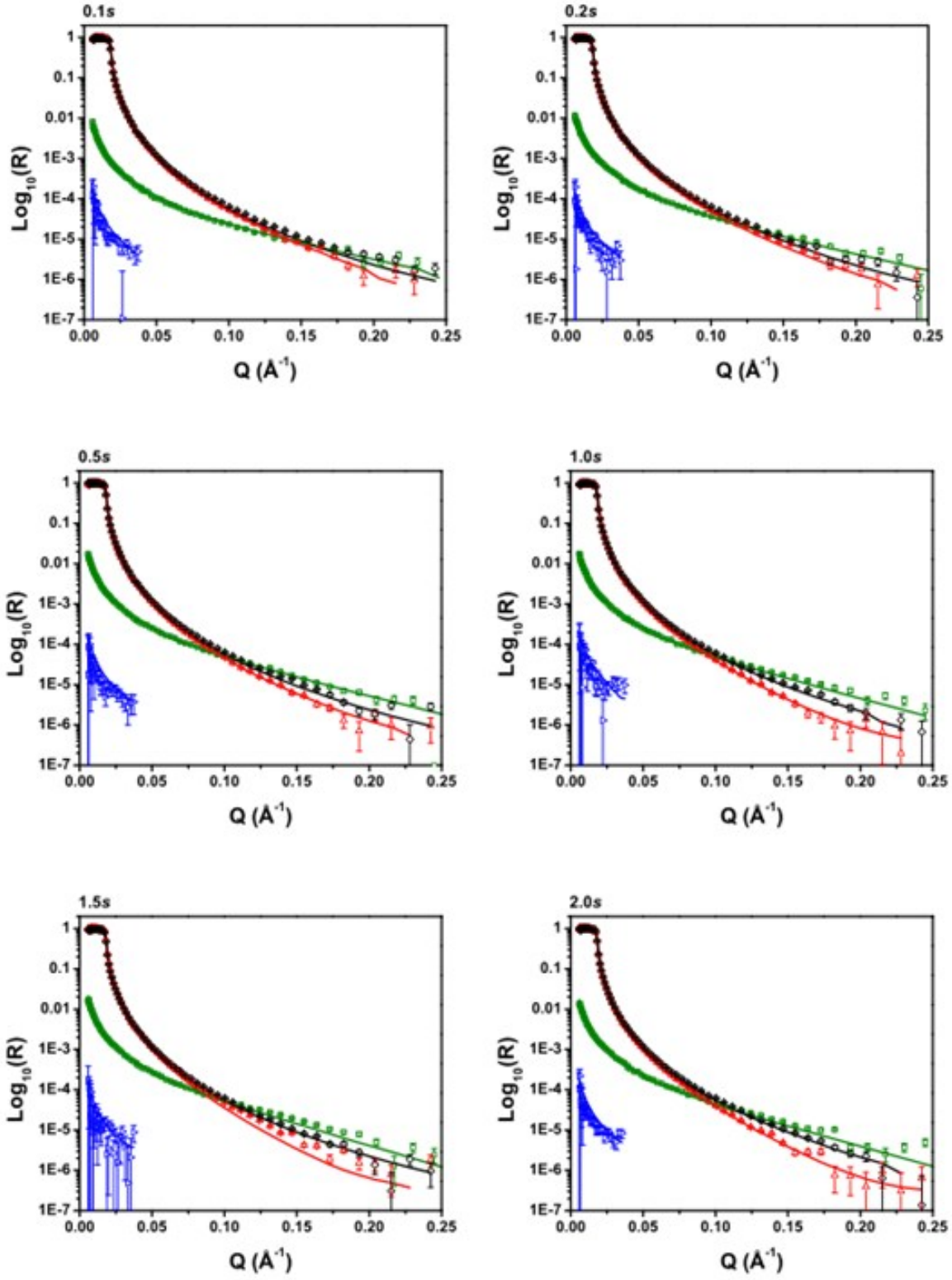

Figure SI3: Specular neutron reflection profiles for the adsorption of SDS and TE at the air-water interface before the additional spreading of TE in a carrier solvent (hexane) at temperature, T = 298 K. The solid lines represent the calculated simultaneous model fits using the global fit routine.

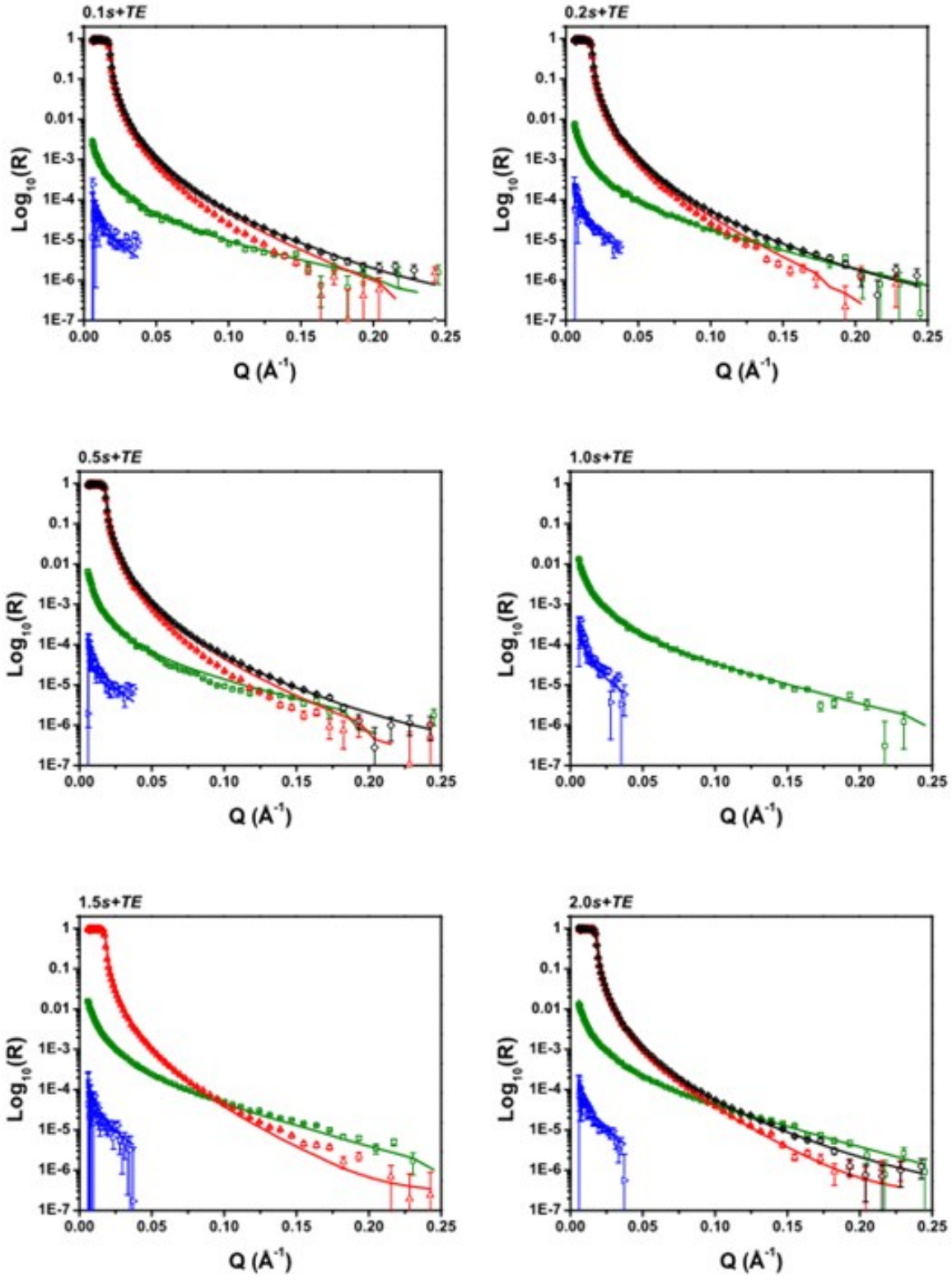

Figure SI4: Specular neutron reflection profiles for the adsorption of SDS and TE at the air-water interface after the additional spreading of TE in a carrier solvent (hexane) at temperature, T = 298 K. The solid lines represent the calculated simultaneous model fits using the global fit routine.

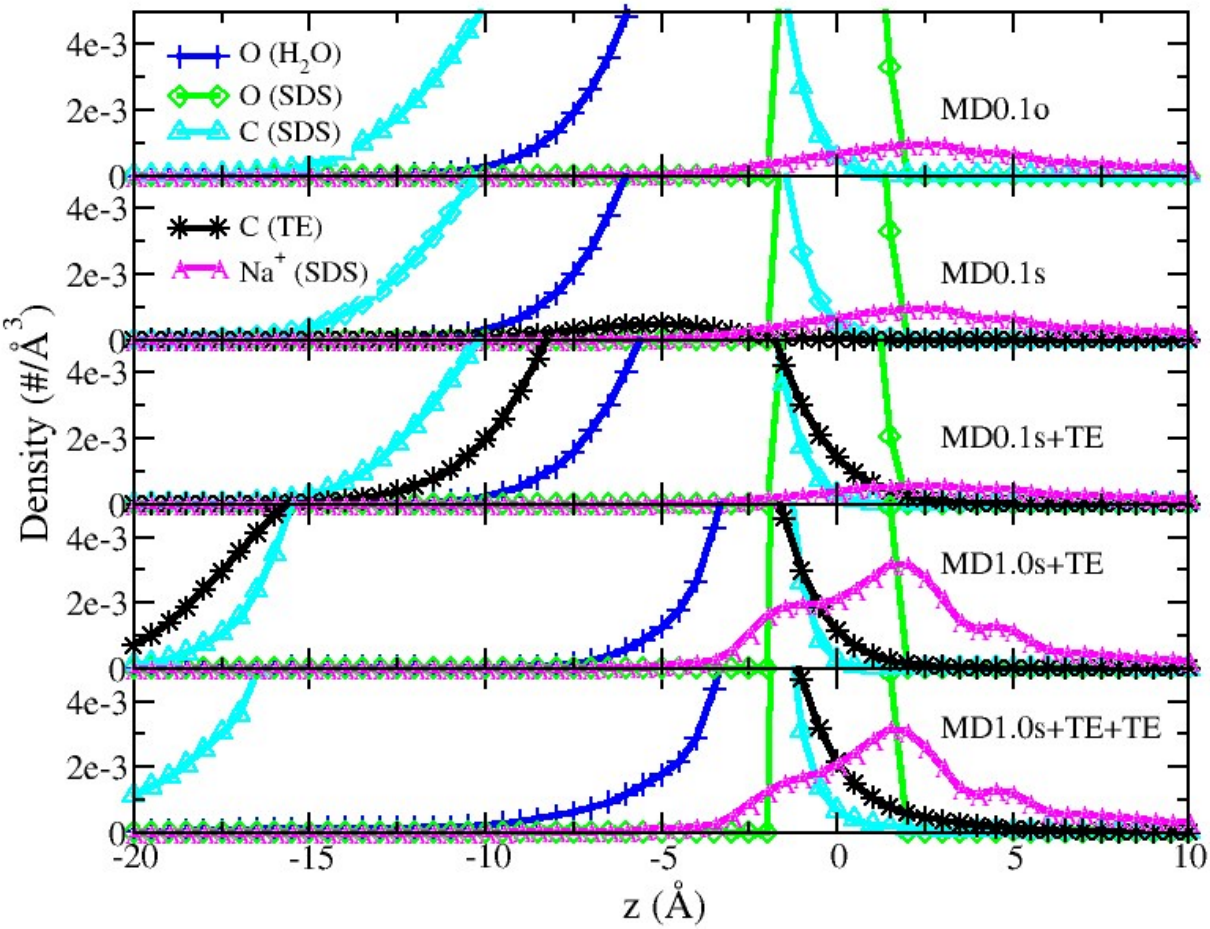

Figure SI5: Plots of the intrinsic densities for the various simulated systems (as shown in Fig. 8 of the manuscript) which have been modified such that the density of the Na^+ ions can be seen more easily. The colours green, cyan and magenta are used to depict the density of SDS elements: oxygen, carbon, and sodium counterions respectively. The colours blue and black are used to depict the density of oxygen atoms in water and carbon atoms in TE molecules respectively.

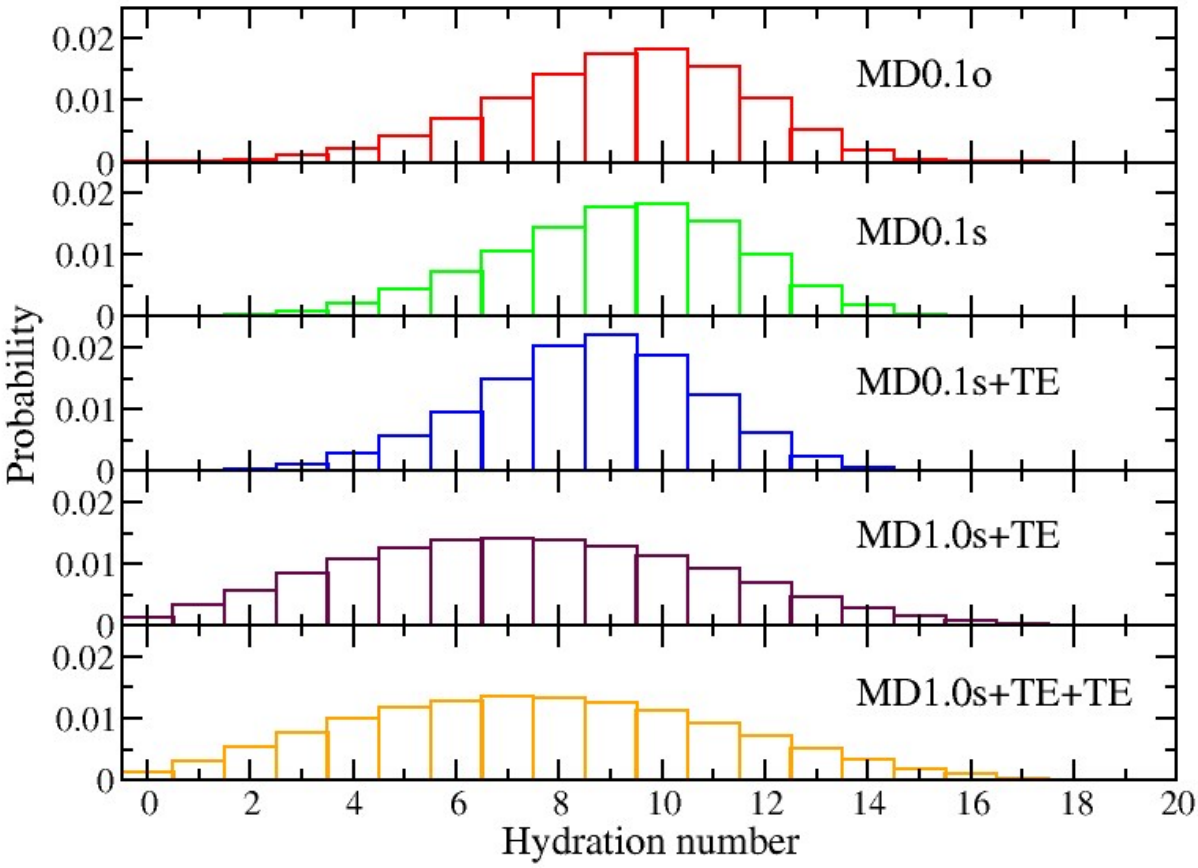

Figure SI6: Histograms showing the probability of an SDS molecule in the monolayers having a given number of hydrating water molecules around the head group.

Detailed description of the neutron reflectivity fitting procedure for Models 1–5

The surface excess of a species i, Γ_i, in a single uniform layer j is given by:

$$\Gamma_i = SLD_i * d_j / (SL_i * N_A) \quad 0.1$$

where SLD is the scattering length density and SL is the scattering length of species i, d is the thickness of layer j, and N_A is Avogadro's number. The value of Γ_i in a single layer j that also contains other species is given by:

$$\Gamma_i = SLD_i * d_j * VF_{i,j} / (SL_i * N_A) \quad 0.2$$

$VF_{i,j}$ is the volume fraction of species i in layer j. The value of Γ_i in units of μmol/m^2 may be expressed as:

$$\Gamma_i = SLD_i * d_j * VF_{i,j} / (SL_i * 0.0602) \quad 0.3$$

where for simplification the input units of SLD_i is in 10^{-6} Å^{-2}, d_j is in Å, and SL is in 10^{-15} m.

In this work, the layer roughness values for any model were constrained to be the same, as there was not enough information in the data to impose different values for different layers, and the value was 4 Å, which is consistent with capillary wave theory[1,2]. The 3 parameters that were fitted, fixed or constrained in modeling Γ_i with respect to any layer j are: (1) the scattering length density of layer j, SLD_j, (2) d_j and (3) the solvent penetration of layer j, SP_j (in %), where:

$$SP_j = 100 * VF_{solvent,j} \quad 0.4$$

It is important to note that SLD_j is the average SLD of the components in layer j weighted by their volume fractions *excluding* solvent:

$$SLD_j = \Sigma_i (SLD_{i,j} * VF_{i,j}) / \Sigma_i VF_{i,j} \quad 0.5$$

where

$$\Sigma_i VF_{i,j} + VF_{solvent,j} = 1 \quad 0.6$$

The co-refinement tool of the software was used to model all 4 measured isotopic contrasts of the 2.0s+TE samples simultaneously using the global fit routine. The genetic optimization algorithm was used with the error and q-resolution waves included, and the starting values of the fitted parameters were consistent with the surface excesses resolved in the compositional analysis. The fitting parameters and constraints are detailed below. Models 1 and 2 combined the tails and head groups (including counter ions) of SDS into a single layer while Models 3, 4

and 5 separated the contributions of tails and head groups into different layers. The location of TE varied according to the model. In Models 3, 4 and 5, the head group layer thickness was fixed at 4 Å based on the result of an iterative procedure to determine its optimum value as described in the main text. In Models 2 and 5, the TE layer thickness was fixed at 4 Å based on a calculation of its size. The calculations constrained Γ_{TE} and Γ_{SDS} to be equivalent in all contrasts for each model, while in Models 3, 4 and 5 the following constraint was also respected:

$$\Gamma_{SDS} = \Gamma_{SDS\text{-}tails} = \Gamma_{SDS\text{-}heads} \quad 0.7$$

For each model, the fitted parameters are indicated in bold. It may be noted that the following intricate and laborious measures are imposed by the lack of possibility to apply the necessary constraints in the published version of the used software. Nevertheless, here we publish a step-by-step guide to circumvent this problem, which can be applied to a range of systems involving interactions of species with soluble surfactant or insoluble lipid monolayers.

Model 1

Model 1 consists of a single uniform layer: layer 1 containing SDS, TE and solvent. The parameters $\mathbf{d_1}$ and $\mathbf{SP_1}$ were each constrained to be equal in all 4 isotopic contrasts and were fitted. The parameter $\mathbf{SLD_1}$ was constrained to be equal in the 2 isotopic contrasts involving deuterated surfactant and was also fitted while the value was constrained to be equal in the 2 isotopic contrasts involving hydrogenous surfactant but was calculated using an iterative procedure to respect the surfactant-to-drug stoichiometry in all 4 isotopic contrasts; an arbitrary starting value of 0.5×10^{-6} Å^{-2}, between the respective values of hydrogenous surfactant and the drug, was used. In general, with respect to any isotopic contrast:

$$VF_{SDS,1} = ((100 - \mathbf{SP_1})/100)*(SLD_1 - SLD_{TE})/(SLD_{SDS} - SLD_{TE}) \quad 1.1$$

$$VF_{TE,1} = ((100 - \mathbf{SP_1})/100)*(SLD_{SDS} - SLD_1)/(SLD_{SDS} - SLD_{TE}) \quad 1.2$$

$$SLD_1 = (SLD_{SDS}*VF_{SDS,1} + SLD_{TE}*VF_{TE,1})/(VF_{SDS,1} + VF_{TE,1}) \quad 1.3$$

where

$$VF_{SDS,1} + VF_{TE,1} + VF_{solvent,1} = 1 \quad 1.4$$

For the 2 isotopic contrasts involving deuterated surfactant:

$$VF_{dSDS,1} = ((100 - \mathbf{SP_1})/100)*(\mathbf{SLD_{dSDS/TE,1}} - SLD_{TE})/(SLD_{dSDS} - SLD_{TE}) \quad 1.5$$

$$\mathbf{SLD_{dSDS/TE,1}} = (SLD_{dSDS}*VF_{SDS,1} + SLD_{TE}*VF_{TE,1})/(VF_{SDS,1} + VF_{TE,1}) \quad 1.6$$

and for the 2 isotopic contrasts involving hydrogenous surfactant:

$$VF_{hSDS,1} = ((100 - \mathbf{SP_1})/100)*(SLD_{hSDS/TE,1} - SLD_{TE})/(SLD_{hSDS} - SLD_{TE}) \quad 1.7$$

$$SLD_{hSDS/TE,1} = (SLD_{hSDS}*VF_{SDS,1} + SLD_{TE}*VF_{TE,1})/(VF_{SDS,1} + VF_{TE,1}) \quad 1.8$$

which simplifies to:

$$SLD_{hSDS/TE,1} = (SLD_{hSDS/TE,1}*(\mathbf{SLD_{dSDS/TE,1}} - SLD_{TE})/(SLD_{dSDS} - SLD_{TE})) + (SLD_{TE}*(SLD_{dSDS} - \mathbf{SLD_{dSDS/TE,1}})/(SLD_{dSDS} - SLD_{TE})) \quad 1.9$$

All 3 fitted parameters were refined, the value of $SLD_{hSDS/TE,1}$ was then calculated using eq. 1.9, and this parameter was updated in the model. The fitting procedure was then performed repeatedly until the input and output values of this calculation were equivalent.

$$\Gamma_{SDS} = SLD_{SDS}*\mathbf{d_1}*VF_{SDS,1}/(SL_{SDS}*0.0602) \quad 1.10$$

$$\Gamma_{SDS} = SLD_{SDS}*\mathbf{d_1}*(((100 - \mathbf{SP_1})/100)*(\mathbf{SLD_1} - SLD_{TE})/(SLD_{SDS} - SLD_{TE}))/(SL_{SDS}*0.0602) \quad 1.11$$

$$\Gamma_{TE} = SLD_{TE}*\mathbf{d_1}*VF_{TE,1}/(SL_{TE}*0.0602) \quad 1.12$$

$$\Gamma_{TE} = SLD_{TE}*\mathbf{d_1}*(((100 - \mathbf{SP_1})/100)*(SLD_{SDS} - \mathbf{SLD_1})/(SLD_{SDS} - SLD_{TE}))/(SL_{TE}*0.0602) \quad 1.13$$

Model 2

Model 2 consists of two uniform layers: layer 1 containing SDS, and layer 2 containing TE and solvent. The parameters $\mathbf{d_1}$ and $\mathbf{SP_2}$ were each constrained to be equal in all 4 isotopic contrasts and were fitted. The parameters $SLD_1 = SLD_{SDS}$ (according to the isotopic contrast), $SP_1 = 0$, $SLD_2 = SLD_{TE}$ and $d_2 = 4$ Å were fixed.

$$VF_{SDS,1} = (100 - SP_1)/100 \quad 2.1$$

$$VF_{SDS,1} = 1 \quad 2.2$$

$$VF_{TE,2} = (100 - \mathbf{SP_2})/100 \quad 2.3$$

$$\Gamma_{SDS} = SLD_{SDS}*\mathbf{d_1}*VF_{SDS,1}/(SL_{SDS}*0.0602) \quad 2.4$$

$$\Gamma_{SDS} = SLD_{SDS}*\mathbf{d_1}/(SL_{SDS}*0.0602) \quad 2.5$$

$$\Gamma_{TE} = SLD_{TE}*d_2*VF_{TE,2}/(SL_{TE}*0.0602) \quad 2.6$$

$$\Gamma_{TE} = SLD_{TE}*d_2*((100 - \mathbf{SP_2})/100)/(SL_{TE}*0.0602) \quad 2.7$$

Model 3

Model 3 consists of two uniform layers: layer 1 containing SDS tails and TE, and layer 2 containing SDS head groups and solvent. The parameter $\mathbf{d_1}$ was constrained to be equal in all 4 isotopic contrasts and was fitted. The parameter $\mathbf{SLD_1}$ was constrained to be equal in the 2 isotopic contrasts involving deuterated surfactant and fitted, while the value was constrained to be equal in the 2 isotopic contrasts involving hydrogenous surfactant but was calculated using an iterative procedure to respect the surfactant-to-drug stoichiometry in all 4 isotopic contrasts; an arbitrary starting value of 0.5 x 10^{-6} $Å^{-2}$, between the respective values of hydrogenous surfactant tails and the drug, was used. The parameters $SP_1 = 0$, $d_2 = 4$ Å, and $SLD_2 = SLD_{SDS\text{-}heads}$ were fixed. The parameter SP_2 was calculated using an iterative procedure to respect the equal number of tails and head groups in the respective layers; an arbitrary starting value of 50% was used. In general, with respect to any isotopic contrast:

$$VF_{SDS\text{-}tails,1} = (SLD_1 - SLD_{TE})/(SLD_{SDS\text{-}tails} - SLD_{TE}) \quad 3.1$$

$$VF_{TE,1} = (SLD_{SDS\text{-}tails} - SLD_1)/(SLD_{SDS\text{-}tails} - SLD_{TE}) \quad 3.2$$

$$SLD_1 = SLD_{SDS\text{-}tails}*VF_{SDS,1} + SLD_{TE}*VF_{TE,1} \quad 3.3$$

where

$$VF_{SDS\text{-}tails,1} + VF_{TE,1} = 1 \quad 3.4$$

For the 2 isotopic contrasts involving deuterated surfactant:

$$VF_{dSDS\text{-}tails,1} = (\mathbf{SLD_{dSDS\text{-}tails/TE,1}} - SLD_{TE})/(SLD_{dSDS\text{-}tails} - SLD_{TE}) \quad 3.5$$

$$\mathbf{SLD_{dSDS\text{-}tails/TE,1}} = (SLD_{dSDS\text{-}tails}*VF_{SDS,1} + SLD_{TE}*VF_{TE,1})/(VF_{SDS\text{-}tails,1} + VF_{TE,1}) \quad 3.6$$

and for the 2 isotopic contrasts involving hydrogenous surfactant:

$$VF_{hSDS\text{-}tails,1} = (SLD_{hSDS\text{-}tails/TE,1} - SLD_{TE})/(SLD_{hSDS\text{-}tails} - SLD_{TE}) \quad 3.7$$

$$SLD_{hSDS\text{-}tails/TE,1} = SLD_{hSDS\text{-}tails}*VF_{SDS\text{-}tails,1} + SLD_{TE}*VF_{TE,1} \quad 3.8$$

which simplifies to:

$$SLD_{hSDS\text{-}tails/TE,1} = (SLD_{hSDS\text{-}tails/TE,1}*(\mathbf{SLD_{dSDS\text{-}tails/TE,1}} - SLD_{TE})/(SLD_{dSDS\text{-}tails} - SLD_{TE})) + (SLD_{TE}*(SLD_{dSDS\text{-}tails} - \mathbf{SLD_{dSDS\text{-}tails/TE,1}})/(SLD_{dSDS\text{-}tails} - SLD_{TE})) \quad 3.9$$

All 3 fitted parameters were refined, the value of $SLD_{hSDS\text{-}tails/TE,1}$ was then calculated using eq. 3.9, and this parameter was updated in the model. The fitting procedure was then performed repeatedly until the input and output values of this calculation were equivalent.

$$\Gamma_{SDS\text{-}tails} = SLD_{SDS\text{-}tails}*\mathbf{d_1}*VF_{SDS\text{-}tails,1}/(SL_{SDS\text{-}tails}*0.0602) \quad 3.10$$

$$\Gamma_{SDS\text{-}tails} = SLD_{SDS\text{-}tails}*\mathbf{d_1}*((\mathbf{SLD_1} - SLD_{TE})/(SLD_{SDS\text{-}tails} - SLD_{TE}))/(SL_{SDS\text{-}tails}*0.0602) \quad 3.11$$

$$\Gamma_{TE} = SLD_{TE}*\mathbf{d_1}*VF_{TE,1}/(SL_{TE}*0.0602) \quad 3.12$$

$$\Gamma_{TE} = SLD_{TE}*\mathbf{d_1}*((SLD_{SDS\text{-}tails} - \mathbf{SLD_1})/(SLD_{SDS\text{-}tails} - SLD_{TE}))/(SL_{TE}*0.0602) \quad 3.13$$

$$\Gamma_{SDS\text{-}heads} = SLD_{SDS\text{-}heads}*d_2*VF_{SDS\text{-}heads,2}/(SL_{SDS\text{-}heads}*0.0602) \quad 3.14$$

$$SP_2 = 100*(1 - VF_{SDS\text{-}heads,2}) \quad 3.15$$

$$\Gamma_{SDS\text{-}heads} = SLD_{SDS\text{-}heads}*d_2*((100 - SP_2)/100)/(SL_{SDS\text{-}heads}*0.0602) \quad 3.16$$

$$\Gamma_{SDS\text{-}tails} = \Gamma_{SDS\text{-}heads} \quad 3.17$$

$$SLD_{SDS\text{-}tails}*\mathbf{d_1}*((\mathbf{SLD_1} - SLD_{TE})/(SLD_{SDS\text{-}tails} - SLD_{TE}))/(SL_{SDS\text{-}tails}*0.0602) = SLD_{SDS\text{-}heads}*d_2*((100 - SP_2)/100)/(SL_{SDS\text{-}heads}*0.0602) \quad 3.18$$

$$SP_2 = 100 - 100*(SLD_{SDS\text{-}tails}*\mathbf{d_1}*((\mathbf{SLD_1} - SLD_{TE})/(SLD_{SDS\text{-}tails} - SLD_{TE}))*SL_{SDS\text{-}heads})/(SLD_{SDS\text{-}heads}*d_2*SL_{SDS\text{-}tails}) \quad 3.19$$

SP_2 is a parameter that is fixed in the model but its value depends on the output as a result of the refinement of the fitted parameters. It is necessary to respect the equal number of surfactant tails and head groups in the system, yet the proper calculated value of SP_2 using eq. 3.19 may not be the same as the starting value used in the model. The fitting was therefore performed iteratively by using the calculated value of SP_2 as the input in the model – while in turn refining the first iterative calculation above – until the corresponding input and output values were equivalent, following which:

$$\Gamma_{SDS} = \Gamma_{SDS\text{-}tails} = \Gamma_{SDS\text{-}heads} \quad 3.20$$

$$\Gamma_{SDS} = SLD_{SDS\text{-}tails}*\mathbf{d_1}*((\mathbf{SLD_1} - SLD_{TE})/(SLD_{SDS\text{-}tails} - SLD_{TE}))/(SL_{SDS\text{-}tails}*0.0602) \quad 3.21$$

$$\Gamma_{TE} = SLD_{TE}*\mathbf{d_1}*((SLD_{SDS\text{-}tails} - \mathbf{SLD_1})/(SLD_{SDS\text{-}tails} - SLD_{TE}))/(SL_{TE}*0.0602) \quad 3.22$$

Model 4

Model 4 consists of two uniform layers: layer 1 containing SDS tails, and layer 2 containing SDS head groups, TE and solvent. The parameters $\mathbf{d_1}$ and $\mathbf{SLD_2}$ were each constrained to be equal in all 4 isotopic contrasts and were fitted. The parameters $SLD_1 = SLD_{SDS\text{-}tails}$ (according to the isotopic contrast), $SP_1 = 0$ and $d_2 = 4$ Å were fixed. The parameter SP_2 was calculated using an iterative procedure to respect the equal number of tails and head groups in the respective layers; an arbitrary starting value of 50% was used.

$$VF_{SDS\text{-}tails,1} = (100 - SP_1)/100 \quad 4.1$$

$$VF_{SDS\text{-}tails,1} = 1 \quad 4.2$$

$$\Gamma_{SDS\text{-}tails} = SLD_{SDS\text{-}tails}*\mathbf{d_1}*VF_{SDS\text{-}tails,1}/(SL_{SDS\text{-}tails}*0.0602) \quad 4.3$$

$$\Gamma_{SDS\text{-}tails} = SLD_{SDS\text{-}tails}*\mathbf{d_1}/(SL_{SDS\text{-}tails}*0.0602) \quad 4.4$$

$$VF_{SDS\text{-}heads,2} = ((100 - SP_2)/100)*(\mathbf{SLD_2} - SLD_{TE})/(SLD_{SDS\text{-}heads} - SLD_{TE}) \quad 4.5$$

$$VF_{TE,2} = ((100 - SP_2)/100)*(SLD_{SDS\text{-}heads} - \mathbf{SLD_2})/(SLD_{SDS\text{-}heads} - SLD_{TE}) \quad 4.6$$

$$\Gamma_{SDS\text{-}heads} = SLD_{SDS\text{-}heads}*d_2*VF_{SDS\text{-}heads,2}/(SL_{SDS\text{-}heads}*0.0602) \quad 4.7$$

$$\Gamma_{SDS\text{-}heads} = SLD_{SDS\text{-}heads}*d_2*(((100 - SP_2)/100)*(\mathbf{SLD_2} - SLD_{TE})/(SLD_{SDS\text{-}heads} - SLD_{TE}))/(SL_{SDS\text{-}heads}*0.0602) \quad 4.8$$

$$\Gamma_{SDS\text{-}tails} = \Gamma_{SDS\text{-}heads} \quad 4.9$$

$$SLD_{SDS\text{-}tails}*\mathbf{d_1}/(SL_{SDS\text{-}tails}*0.0602) = SLD_{SDS\text{-}heads}*d_2*(((100 - SP_2)/100)*(\mathbf{SLD_2} - SLD_{TE})/(SLD_{SDS\text{-}heads} - SLD_{TE}))/(SL_{SDS\text{-}heads}*0.0602) \quad 4.10$$

$$SP_2 = 100 - 100*(SLD_{SDS\text{-}tails}*\mathbf{d_1}*(SLD_{SDS\text{-}heads} - SLD_{TE})*SL_{SDS\text{-}heads})/(SLD_{SDS\text{-}heads}*d_2*(\mathbf{SLD_2} - SLD_{TE})*SL_{SDS\text{-}tails}) \quad 4.11$$

SP_2 is a parameter that is fixed in the model but its value depends on the output as a result of the refinement of the fitted parameters. It is necessary to respect the equal number of surfactant tails and head groups in the system, yet the proper calculated value of SP_2 using eq.

4.11 may not be the same as the starting value used in the model. The fitting was therefore performed iteratively by using the calculated value of SP_2 as the input in the model until the corresponding input and output values were equivalent, following which:

$$\Gamma_{SDS} = \Gamma_{SDS\text{-}tails} = \Gamma_{SDS\text{-}heads} \quad 4.12$$

$$\Gamma_{SDS} = SLD_{SDS\text{-}tails} * \mathbf{d_1} / (SL_{SDS\text{-}tails} * 0.0602) \quad 4.13$$

$$\Gamma_{TE} = SLD_{TE} * d_2 * (((100 - SP_2)/100) * (SLD_{SDS\text{-}heads} - \mathbf{SLD_2}) / (SLD_{SDS\text{-}heads} - SLD_{TE})) / (SL_{TE} * 0.0602) \quad 4.14$$

Model 5

Model 5 consists of three uniform layers: layer 1 containing SDS tails, layer 2 containing SDS head groups and solvent, and layer 3 containing TE and solvent. The parameters $\mathbf{d_1}$ and $\mathbf{SP_3}$ were each constrained to be equal in all 4 isotopic contrasts and were fitted. The parameters $SLD_1 = SLD_{SDS\text{-}tails}$ (according to the isotopic contrast), $SP_1 = 0$, $SLD_1 = SLD_{SDS\text{-}heads}$, $d_2 = 4$ Å, $SLD_3 = SLD_{TE}$, and $d_3 = 4$ Å were fixed. The parameter SP_2 was calculated using an iterative procedure to respect the equal number of tails and head groups in the respective layers; an arbitrary starting value of 50% was used.

$$VF_{SDS\text{-}tails,1} = (100 - SP_1)/100 \quad 5.1$$

$$VF_{SDS\text{-}tails,1} = 1 \quad 5.2$$

$$\Gamma_{SDS\text{-}tails} = SLD_{SDS\text{-}tails} * \mathbf{d_1} * VF_{SDS\text{-}tails,1} / (SL_{SDS\text{-}tails} * 0.0602) \quad 5.3$$

$$\Gamma_{SDS\text{-}tails} = SLD_{SDS\text{-}tails} * \mathbf{d_1} / (SL_{SDS\text{-}tails} * 0.0602) \quad 5.4$$

$$\Gamma_{SDS\text{-}heads} = SLD_{SDS\text{-}heads} * d_2 * VF_{SDS\text{-}heads,2} / (SL_{SDS\text{-}heads} * 0.0602) \quad 5.5$$

$$SP_2 = 100 * (1 - VF_{SDS\text{-}heads,2}) \quad 5.6$$

$$\Gamma_{SDS\text{-}heads} = SLD_{SDS\text{-}heads} * d_2 * ((100 - SP_2)/100) / (SL_{SDS\text{-}heads} * 0.0602) \quad 5.7$$

$$\Gamma_{SDS\text{-}tails} = \Gamma_{SDS\text{-}heads} \quad 5.8$$

$$SLD_{SDS\text{-}tails} * \mathbf{d_1} / (SL_{SDS\text{-}tails} * 0.0602) = SLD_{SDS\text{-}heads} * d_2 * ((100 - SP_2)/100) / (SL_{SDS\text{-}heads} * 0.0602) \quad 5.9$$

$$SP_2 = 100 - 100 * (SLD_{SDS\text{-}tails} * \mathbf{d_1} * SL_{SDS\text{-}heads}) / (SLD_{SDS\text{-}heads} * d_2 * SL_{SDS\text{-}tails}) \quad 5.10$$

SP_2 is a parameter that is fixed in the model but its value depends on the output as a result of

the refinement of the fitted parameters. It is necessary to respect the equal number of surfactant tails and head groups in the system, yet the proper calculated value of SP_2 using eq. 5.10 may not be the same as the starting value used in the model. The fitting was therefore performed iteratively by using the calculated value of SP_2 as the input in the model until the corresponding input and output values were equivalent, following which:

$$\Gamma_{SDS} = \Gamma_{SDS\text{-}tails} = \Gamma_{SDS\text{-}heads} \quad 5.11$$

$$\Gamma_{SDS} = SLD_{SDS\text{-}tails} * \mathbf{d_1} / (SL_{SDS\text{-}tails} * 0.0602) \quad 5.12$$

$$\mathbf{SP_3} = 100 * (1 - VF_{TE,3}) \quad 5.13$$

$$\Gamma_{TE} = SLD_{TE} * d_3 * VF_{TE,3} / (SL_{TE} * 0.0602) \quad 5.14$$

$$\Gamma_{TE} = SLD_{TE} * d_3 * ((100 - \mathbf{SP_3})/100) / (SL_{TE} * 0.0602) \quad 5.15$$

The application of the 5 models to the experimental data for 2.0s+TE in all 4 isotopic contrasts resulted in the following fitted parameters, calculated parameters and surface excesses:

Model	Fitted Parameters	Calculated Parameters	Γ_{SDS} ($\mu mol/m^2$)	Γ_{TE} ($\mu mol/m^2$)
1	d_1 = 11.6 Å $SLD_{dSDS/TE,1}$ = 4.97 x 10^{-6} $Å^{-2}$ SP_1 = 0%	$SLD_{hSDS/TE,1}$ = 0.45 x 10^{-6} $Å^{-2}$	3.33	0.85
2	d_1 = 8.4 Å SP_2 = 12%		3.35	0.92
3	d_1 = 12.7 Å $SLD_{dSDS\text{-}tails/TE,1}$ = 4.35 x 10^{-6} $Å^{-2}$	$SLD_{hSDS\text{-}tails/TE,1}$ = 0.03 x 10^{-6} $Å^{-2}$ SP_2 = 71%	3.50	1.37
4	d_1 = 6.5 Å SLD_2 = 1.83 x 10^{-6} $Å^{-2}$	SP_2 = 12%	3.04	0.75
5	d_1 = 6.8 Å SP_3 = 34%	SP_2 = 71%	3.18	0.69