

Colloid and Interface Chemistry for Nanotechnology

D43 Training School "Fluids and Solid Interfaces"

**Tutroial: Scattering from liquid-Liquid interfaces**

1. Calculate the scattering length density, ρ for a silicon substrate and hence a value for its critical angle θc at a wavelength of 5.0 Å.

[Properties of Si: density = 2.33 g cm–3; atomic weight = 28 g mol–1; neutron scattering amplitude = 0.42 × 10–12 cm].

 = 0.42 ×10-12 cm = 0.42 × 10-12 cm

M = 28 g mol-1

 =

Å-2

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1. Calculate the difference in the scattering length densities for Iron, for neutron spin aligned parallel and antiparallel to the Fe magnetic moment.

|  |  |
| --- | --- |
| Neutron scattering length, b | 9.45 fm |
| Magnetic moment  | 2.2 µb |
| Density | 7870 kg m-3 |
| Atomic mass | 55.845 g mol-1 |

C = 2.695 fm µb-1



Scattering length density of Fe for spin up (δ+) and spin down (δ-) neutrons is given by



Å-2

Å-2

The difference is Å-2

1. Scattering wave vector is defined as;



Derive an expression for the resolution.

The equation to calculate errors in quadrature is:



Substituting for Q and partially differentiating with respect to θ and λ;



Divide through by Q



1. A 20 Å neutron and Airbus A380 leave Sofia airport at the same time bound for Chicago by the same route. Assuming Airbus covers 5600 kilometre in 9 hours, which arrives first at Chicago and by how much. (You may neglect the finite lifetime of neutrons!)

Airbus 

Neutron 

1 J = 1Nm = 1 kg ms-2 m = 1 Kg m2s-2

Hence Js Kg-1m-1 = Kgm2s-2Kg-1m-1 = ms-1

Neutron arrives first by about 68 minutes.

1. What is the energy of 5 Å neutrons in electron-volts, eV?





J2s2 Kg-1m-1 = Kg2m4s-4s2Kg-1m-2 = Kg m2s-2 = J

To convert to eV, divide by the elementary charge:



1. Calculate the theoretical transmission of 1 mm thick layer of water.



Where t is the path length (0.01 cm) and σ total is total cross-section.

H2O

M = 18 g mol-1, ρ = 1.00 gcm-3 thus N = 3.34 ×1022 cm-3

H:

σ coh = 1.8 ×10-24 cm2, σ inc = 80.3 ×10-24 cm2, σ abs = 0.3 ×10-24 cm2

O:

σ coh = 4.2 ×10-24 cm2, σ inc = 0.0 ×10-24 cm2, σ abs = 0.0 ×10-24 cm2

Hence:

σ total =σ coh + σ inc + σ abs  = 2 × (1.8 + 80.3 + 0.03) ×10-24 + 4.2 ×10-24

σ total = 1.69 ×10-22 cm2

T = exp [-3.34 ×1022× 0.1× 1.69×10-22] = 0.57

Absorption cross section is a function of wavelength hence energy. Here the valve is taken for 6 Å neutrons.

1. Small group Exercise:

Computer based analysis of neutron reflectivity data for protein friendly surfaces. This involves analysis of neutron reflectivity data to probe the resistance of a poly (ethylene glycol) (PEG) coated silicon surface to the adsorption of the model protein bovine serum albumin (BSA) from buffered aqueous solution. [**Please see the additional information provided**]