STEM ED/CHM Nanotechnology at UMass Amherst

Sample Calculations

Sample Data

Time of Trial:	5 minutes = 3.0×10^{2} seconds
Width of copper electrode	2 cm = 2.0×10^{-2} meters
Length of electrode in solution	5 cm = 5.0×10^{-2} meters
Average ammeter reading	0.017 ampere = 1.7×10^{-2} Coulombs/second

Sample Nanoscale Calculations

Calculation 1: Calculate the number of electrons that flowed through the circuit in 5 minutes.

$$(1.7 \times 10^{-2}\ \text{Coulombs/sec})(6.24 \times 10^{18}\ e^{-}/\text{Coulomb})(3.0 \times 10^{2}\ \text{seconds}) = 3.18 \times 10^{19} e^{-}$$

Calculation 2: Calculate the number of zinc atoms that formed.

$$\frac{3.18 \times 10^{19}\ e^{-}}{2\ \text{electrons for each zinc ion}} = 1.59 \times 10^{19}\ \text{atoms of zinc}$$

Note: The next three steps would be similar to determining how many marbles form a single layer of marbles on a rectangular desk surface if you know the diameter of each marble.

Zinc atoms in each layer have a diameter of 3.06×10^{-10} meters.

Calculation 3: Calculate the number of atoms of zinc in a row across the width of the copper electrode. Note: Distances are measured in meters.

$$\frac{2.0 \times 10^{-2}\ \text{m}}{3.06 \times 10^{-10}\ \text{m/atom}} = 6.54 \times 10^{7}\ \text{atoms/row}$$

Calculation 4: Calculate the number of atoms in a column along the length of the electrode that was in the solution.

$$\frac{5.0 \times 10^{-2}\ \text{m}}{3.06 \times 10^{-10}\ \text{m/atom}} = 1.63 \times 10^{8}\ \text{atoms/column}$$

Calculation 5: Calculate the number of atoms that formed a single layer on one side of the copper electrode.

$$(6.54 \times 10^{7}\ \text{atoms /row}) \times (1.63 \times 10^{8}\ \text{atoms /column}) = 1.06 \times 10^{16}\ \text{atoms}$$

Calculation 6: Calculate the number of atoms that formed a single layer on both sides of the copper electrode.

$$2 \times 1.06 \times 10^{16}\ \text{atoms} = 2.12 \times 10^{16}\ \text{atoms}$$

Calculation 7: Calculate the average number of layers of zinc atoms.

$$\frac{1.59 \times 10^{19}\ \text{atoms of zinc}}{2.12 \times 10^{16}\ \text{atoms / layer}} = 7.50 \times 10^{2}\ \text{layers of atoms}$$

Remember that zinc atoms in each layer have a diameter of 2.48×10^{-10} meters.

Calculation 8: Calculate the average thickness of the layer of zinc.

$$7.50 \times 10^{2}\ \text{layers of atoms} \times 2.48 \times 10^{-10}\ \text{meter/layer} = 18.6 \times 10^{-8}\ \text{meters}$$

The approximate thickness of the zinc was 186 nanometers.