IntrinsicViscosityofaSolid

One day during class, I handed around a manuscript that was in my possession for review. Strictly speaking, these things are confidential, but the students did not have long enough to see the data or steal ideas—so no ethical dilemma. Part of your job as a graduate student (those of you who are graduate students) is to learn to write these manuscripts. This one was typical: 28 pages double spaced, appendix with some arcane equations, 9 figures, 42 references.

I was excited about showing the students *this* manuscript because it used intrinsic viscosity, which we had just discussed. It even had the Einstein relation for solid spheres:

$$[\eta] = \frac{10\pi R^3 N_a}{3M}$$

where R is the sphere radius, M the sphere molecular weight and N_a is Avogadro's number. These authors were interested in colloidal silica spheres and were using a spiffy new recipe (*J. Am. Chem. Soc.* 2003, 125, 3712) that permits production of very small spheres—e.g., $R = 1.2$ nm.

a. Using $R = 1.2$ nm and a measured value of $[\eta] = 0.03$ dL/g, compute the particle molecular weight.

$$\frac{10\pi R^3 N_a}{3m} = [\eta] \Rightarrow \frac{10\pi\,(1.2\times10^{-7}\,\text{cm})^3\;6.023\times10^{23}/\text{mol}}{3\,(0.03\,\frac{dL}{g})} = 3{,}633\ g/mol$$

b. Is such a particle really to be regarded as a molecule?

Yup. The Molecular weight seems fine and it has $[\eta]$.

c. What is the density of this particle?

$$\rho = \frac{M}{V} = \frac{MW/N_a}{V} = \frac{(3{,}633\ g/mol)/6.023\times10^{23}\ \text{particles}}{4/3\,\pi\,(1.2\times10^{-7}\,\text{cm})^3} = 0.83\ g/dL$$

d. This particle is much too small to size by light scattering as you know it. How do you suppose they know its radius is 1.2 nm?

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