GENETICALLY ENGINEERED POLYPEPTIDES FOR CONTROL OF Cu_2O NANOSTRUCTURE

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Nature builds hard tissues like bones, teeth, and shells by combining proteins with inorganic materials; these biocomposites often have properties that surpass their constituent elements. Biocomposite materials are generally created in aqueous solutions near room temperature using a protein template that facilitates the growth and ordering of a specific mineral.[1] Similarly, electrochemical methods can also produce inorganic materials under mild aqueous conditions, though generally, electrodeposited materials do not spontaneously form hierarchical structures to the same degree as biological systems. We describe an efforts to discover and use small polypeptide sequences (Inorganic Binding Peptides, IBPs) that selectively bind cuprous oxide (Cu_2O), a semiconductor with a direct band gap of 2.2 eV and four well-defined exciton bands in the visible spectrum.[2] Cu_2O IBPs are identified using GI826 *Escherichia coli* cells harboring the FliTrx combinatorial polypeptide library. The inorganic materials (cuprous oxide and related oxides and hydroxides) are made electrochemically. Once putative Cu_2O binding polypeptides are identified, quantitative binding studies are performed using a TraI::IBP mutant (wild-type TraI is not a Cu_2O binder). Figure 1 shows the binding of the mutant TraI::CN225 to Cu_2O as a function of concentration, evaluated using an electrochemical quartz crystal nanobalance (EQCN). The adsorption coefficient is $K_d=1.2\times10^{-8}$ M, indicating that CN225 imparts Cu_2O affinity to TraI. We are now exploring the use of this Cu_2O binding TraI mutant for the controlled nucleation, growth and hierarchical assembly of Cu_2O made by electrochemical and solution phase growth. Figure 2 is a TEM image of a Cu_2O nanoparticle made by electrochemical/chemical synthesis in protein-containing bufffer. In this talk, we will describe this ongoing project, with special emphasis on the electrochemical preparation and stability of the materials of interest in biologically-compatible electrolytes.

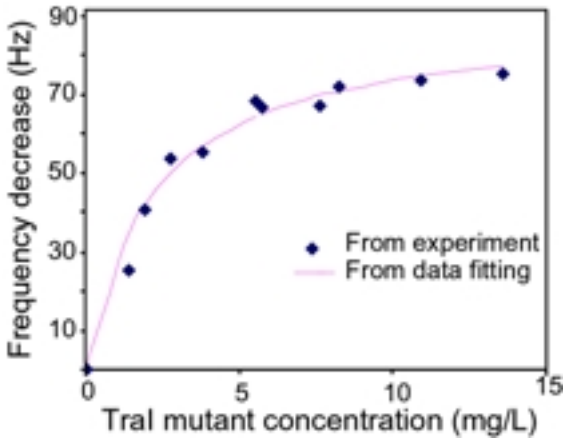

Figure 1 TraI mutant (TraI::CN225) adsorption on Cu_2O surface by EQCN. Fit is a Langmuir adsorption isotherm

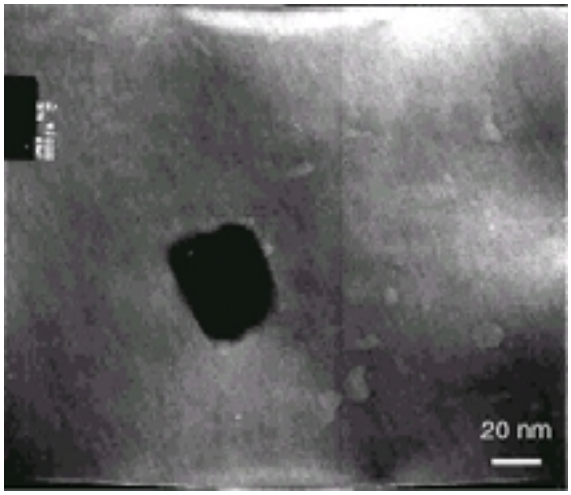

Figure 2 TEM image of a Cu_2O nanoparticle

[1] M. Sarikaya, *Proc. Natl. Acad. Sci. USA*, **96**(25), (1999).

[2] Hodby, J. W.; Jenkins, T. E.; Schwab, C.; Tamura, H.; Trivich, D. *J. Phys. C: Solid State Phys.* **1976,** *9*, 1429