NANO HIGHLIGHT
Encapsulation of Active Enzymes in Conducting Polymer Nanowires

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Nanoscale wires are of interest as components of "electronic nose" sensor and biosensor arrays. Arrays of macroscopic sensors can be used for such diverse applications as determining breath alcohol levels, automotive exhaust safety inspection, and identification of toxic gases. The primary advantage of nanosensors over their macroscopic counterparts is their ability to detect analytes in a power- and area-efficient manner, and to be integrated conveniently into chips that combine the functions of chemical sensing and signal processing. Because of their high specificity for both small molecule and biological analytes, as well as their ability to amplify signals through catalytic reactions, enzymes are key components of these nanosensors.

We have now developed a template-based approach that allows us to encapsulate active enzymes in conducting polymer "stripes" within metallic nanowires.[2] These nanowires can be integrated into test circuits and lithographically patterned sensor arrays suspending them in water and applying an AC voltage to the contact surfaces.[3] Proteins (avidin, streptavidin, catalase) in the polymer segments retain their molecular recognition and catalytic functions. The conjugation of biotin to polymer-bound avidin provides a "hook" for binding other specific sensory or catalytic receptors. In addition to their sensory function, these segmented nanowires are interesting as objects that move autonomously in "fuel" solutions by catalyzing reactions at one end.[4] The incorporation of catalytically active enzymes into polymer segments opens the interesting possibility of using bio-friendly fuels such as glucose to power these nanoscale motors.

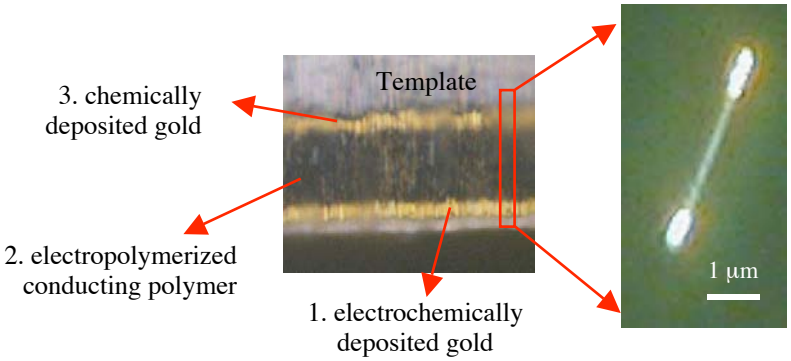

Figure 1. Electrochemical replication of porous templates (in this case an anodic alumina membrane) gives free-standing nanowires containing conducting polymer-embedded proteins[2] between metal end contacts. This procedure typically produces 10^8-10^9 nearly identical nanowires in a single experiment.

References

[1] For further information about this project link to http://www.cse.psu.edu/~nansea or email tom@chem.psu.edu
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[3] P.A. Smith, C. D. Nordquist, T. N. Jackson, T. S. Mayer, B. R. Martin, J. Mbindyo, and T. E. Mallouk, Appl. Phys. Lett. **77**, 1399 (2000).
[4] W. F. Paxton, K. C. Kistler, C. C. Olmeda, A. Sen, S. K. St. Angelo, Y. Cao, T. E. Mallouk, P. Lammert, and V. H. Crespi, J. Am. Chem. Soc., **126**, 13424-13431 (2004).