New opportunities from old chemistry in surface science

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Some century-old chemistry could have a strong impact on important issues in biosensors and other nanotech devices, according to a Purdue University research group.
A team led by Alexander Wei has shown that amines, a large and important class of organic molecules, when mixed with carbon disulfide, can bond to gold more robustly than thiols, which are commonly used materials for giving new functions to metal surfaces.

Gold surfaces are often used as baseplates of sensors and in nanomaterials, and scientists have been searching for stable organic coatings they can attach to gold to form an interface between the organic and inorganic worlds. The group's findings suggest that amines may be the best candidate group of such materials.

"Amines could allow us to expand the range of molecules which can be incorporated into sensors for the biotech field," said Wei, who is an associate professor of chemistry in Purdue's College of Science. "Amines react with carbon disulfide to form dithiocarbamates (DTCs) and appear to be better suited for coating surfaces than thiols, which have been the standard thus far. The DTC chemistry itself has been around for over 100 years, but we think it can offer many opportunities for current applications in biosensors and nanotechnology."

Wei performed the study with his Purdue colleagues Yan Zhao, Waleska Pérez-Segarra and Qicun Shi. Their work appeared in this week's (Vol. 127, No. 20) issue of the *Journal of the American Chemical Society*.

Nanotechnologists and other materials scientists use gold as an interface between electronic components and organic or biomolecular substances. Gold's conductivity and resistance to corrosion makes it an ideal surface for attaching molecules that can detect the presence of proteins in the blood that indicate disease, for example.

"Up to this point, the standard practice has been to modify gold surfaces with thiols, because they are relatively easy to work with and form coatings quickly," Wei said. "Thiols are well known to adsorb, or stick, onto gold surfaces to form highly uniform films with adjustable surface properties. But a drawback to thiols is their intermittent hold on the surface, and the relatively weak chemical bond makes them less attractive for applications that require environmentally durable coatings."

Wei's team found that converting amines into DTCs empower them with an ability to grasp gold surfaces with a strength that thiols do not possess.

"As DTCs, the amines are armed with a 'pincer' made of two sulfur atoms," Wei said. "Thiols are typically bonded to gold by one sulfur atom, like pins stuck in a gold pincushion. DTCs are more like a vice grip, so we hope they will last longer on the gold."

Wei said that although DTCs have been around for a long time, their application to surface chemistry has been overlooked and is long overdue. But Wei cautions that further studies are needed to establish the full scope and limitations of DTCs for various applications.

Wei is associated with Purdue's Birck Nanotechnology Center, which will be one of the largest university facilities in the nation dedicated to nanotechnology research when construction is completed in the summer of 2005. Nearly 100 groups associated with the center are pursuing diverse research topics such as nanometer-sized machines, advanced

materials for nanoelectronics and nanoscale biosensors.

ABSTRACT

Dithiocarbamate Assembly on Gold

Yan Zhao, Waleska Pérez-Segarra, Qicun Shi and Alexander Wei

Gold surfaces are functionalized by stable dithiocarbamate ligands when exposed to carbon disulfide and secondary amines. The adsorbed dithiocarbamates are robust under a wide pH range and can resist displacement by other chemisorptive surfactants, providing an attractive method for conjugating sensitive molecules onto metal surfaces.

Source: Purdue University