Catalytic Treasure

Topology Helps Nanoscale Gold Spur More Chemical Reactions

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Gold, on its own, is regarded as a treasure—a noble and precious metal. In its chemical life, it doesn't react with other elements, or with molecules in the air. However, when gold shrinks down to the nanoscale, it can actually become a good catalyst, changing the rate of other chemical reactions.

Researchers from the University of Tennessee Knoxville Department of Physics, Oak Ridge National Laboratory, and the University of Science and Technology of China (USTC) have shown that when an ultrathin film of gold is layered atop a substrate, or base, of bismuth selenide (Bi_2Se_3), the gold becomes a platform for the adsorption and reaction of both carbon monoxide and oxygen molecules.

The success of their work has largely to do with their use of what's called a *topological insulator* (here the Bi_2Se_3), a new class of quantum materials that exhibit some interesting properties in their own right. In bulk, these materials are insulators, meaning they inhibit the movement of heat and electricity. Their surfaces, however, have special metal-like electronic states that act as conductors, which carry, rather than inhibit, current. The surface states themselves are exceptional; unlike normal surface states that are vulnerable and easily destroyed by defects, impurities, or changes in orientation, these are stable and robust, resisting disorder. Using sophisticated calculations, the research team found that the topological surface states held fast even after the adsorption of the gold layer, and in fact made the gold a better catalyst. They attribute this to another interesting finding: the surface states resemble a "charge reservoir," where electrons can come and go freely and therefore promote interaction between the gold and gas molecules, spurring co-oxidation. The results not only open a new arena for the technological potential of topological insulators, they might also enrich the design principles of future catalysts.

The results were published in the paper "CO Oxidation Facilitated by Robust Surface States on Au-Covered Topological Insulators," which appeared in *Physical Review Letters* in late July and was selected as an "editor's suggestion," based on its potential interest and clear communication, particularly to readers from others fields. It was also featured in the APS online journal *Physics*, titled "Topological Catalysis."

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