experiment "are largely fortuitous." By contrast, the method developed by McCurdy and his team allows the calculation of a highly accurate wave function for the outgoing state that can be interrogated for details of the incoming state and interaction in the same way an experimenter would interrogate a physical system. The researchers acknowledge important advances made earlier by others such as Igor Bray and Andres Stelbovics, whose methods could give the total cross section for ionization of a scattering reaction but could not give specifics such as the directions or energies of outgoing electrons. By contrast, said Thomas Rescigno, a staff physicist at Livermore Lab, "Our work produces absolute answers at the ultimate level of detail."

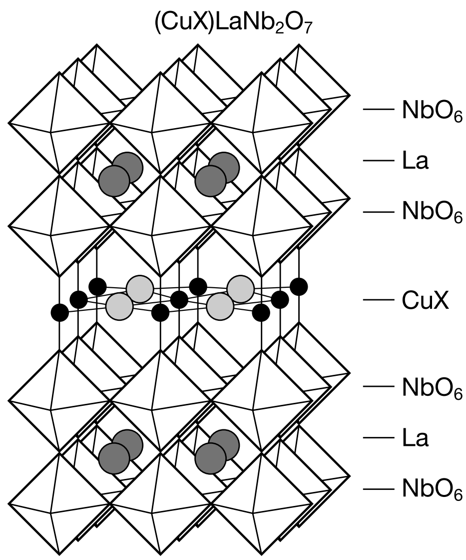
Comparisons with real scattering experiments, such as those recently published by J. Röder et al., who scattered incoming 17.6-eV electrons from hydrogen atoms and measured the angles and energies of the outgoing electrons, prove the accuracy of the new method. The experimental data points match the graph of the cross sections calculated by McCurdy's research team.

"Even if the specific methods have changed, quantum chemistry was founded when the helium atom with two bound electrons was solved—it showed that these problems were, in principle, solvable," McCurdy said. "What we have done is analogous. The details of our method probably won't survive, but we've taken a big step toward treating ionizing collisions of electrons with more complicated atoms and molecules."

The authors conclude that the same computing power and tools necessary for investigating the complexity of increasingly larger systems are also needed "to answer a basic physics question for one of the simplest systems imaginable in physics and chemistry."

Researchers Demonstrate Template for Development of Extended Metal-Anion Arrays

Researchers at the University of New Orleans have synthesized a set of perovskite-related, layered copper-oxyhalides, $(CuX)LaNb_2L_7$, X = Cl and Br), where a copper-halide network was assembled within a double-layered perovskite host (see figure). The synthetic approach that T.A. Kodenkandath and his colleagues of J.B. Wiley's research group describe in the December 1999 issue of the *Journal of the American Chemical Society* demonstrates how host structures can be used as templates in the directed low-temperature



An idealized structure of $(CuX)LaNb_2O_7$. The small dark balls are copper surrounding the large balls, which are X (Cl, Br).

(<350°C) assembly of extended metal-anion arrays.

The research team formed new layered copper-oxyhalide from ion-exchange reactions between $RbLaNb_3O_7$ and the copper-halides CuX_2. While this type of exchange usually involve only cations, in $RbLaNb_2O_7$ the copper and halide co-exchanged ions. The researchers relate this to the smaller layer charge of this host relative to other layered perovskites such as $Na_2La_2Ti_3O_{10}$: "to maintain a charge balance, $Na_2La_2Ti_3O_{10}$ would have to exchange two '$CuCl^+$' units, for which there may not be enough room in the interlayer." X-ray diffraction revealed a novel structure for $(CuX)LaNb_2L_7$ containing unusual CuO_2X_4 octahedra that corner-share with NbO_6 octahedra from the pervoskite slab and edge-share with each other along all four equatorial edges. They have successfully applied this chemistry to similar layered perovskites.

Thermal analysis showed that $(CuX)LaNb_2L_7$ decomposes below 700°C, indicating that the compounds are low-temperature phases. As such, according to the researchers, they are likely not accessible by direct reaction because the parent compound must be synthesized at temperatures >700°C.

The researchers concluded that their method of assembling metal-anion networks may lead to new rationally designed materials as applied to nonmolecular systems.

Modified BHA Crystals May Allow Combustion of Methane with Much Less Pollution

Jackie Ying, an associate professor of chemical engineering at the Massachusetts Institute of Technology, has created a barium hexaaluminate (BHA) catalyst that could make it easier to burn methane while drastically cutting emissions of pollutants from natural-gas power plants. Her research team's challenge was to create a catalyst that would allow the combustion process to start, known as "light-off," at a low temperature, but would also be stable at operating temperatures up to about 1300°C. The new BHA crystals are 30 nm in diameter, even at 1300°C, giving them a surface area ten times higher than the surface area for BHA produced by conventional processing. Light-off went down to 600°C from 700°C for BHA crystals formed by conventional processing.

As reported in the January 6 issue of *Nature*, the researchers created a BHA catalyst through a reverse microemulsion in which water droplets only nanometers in diameter are suspended in oil. When added to the water-oil mixture, the principal "ingredients" for the catalyst preferentially move from the oil into the water droplets, where they react. A final heat treatment and powder recovery complete the process.

Ying said that conventional approaches for producing BHA result in a material that is not well mixed before the heat treatment. As a result, the crystallization must be conducted at temperatures so high that particles undergo severe growth. That decreases their surface area, which in turn decreases their reactivity and limits light-off to about 700°C.

In the new process, however, the diffusion of ingredients into the water droplets creates a much more homogenous mixture, which means that the final crystallization heat treatment can be conducted at a lower temperature. That lower temperature suppresses particle growth, maintains the high BHA surface area and reactivity, and allows a lower light-off temperature.

The researchers furthermore experimented with ceria, which is an active catalyst at low temperatures and might allow the desired light-off. Above ~600°C, however, ceria crystals agglomerate, destroying the material.

The researchers' solution is to add ceria to the reverse microemulsion used to produce the BHA particles. The ceria, too, diffuses from the oil into the water droplets, resulting in BHA particles covered with discrete deposits of ceria. Because the

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ceria crystals are anchored to the BHA and are separated from one another, even at very high temperatures they cannot fuse together. The ceria-coated BHA has a light-off of just about 400°C and can withstand temperatures higher than 1100°C. The catalyst is stable in the presence of water vapor and other potential poisons.

"This combination of low-temperature catalytic activity, high-temperature thermal stability, and poisoning resistance renders our catalysts interesting for potential practical applications in ultralean catalytic combustion of methane," the authors conclude. Ying said that the procedure for creating the material paves the way for materials that could improve other high-temperature processes such as the production of some chemicals.

Positrons Help Locate Nano-Surface Defects in Gold

In a paper published in the November 29 issue of *Physical Review Letters*, a team from Oak Ridge National Laboratory, Lucent Technologies, Fisk University, and Japan's Electrotechnical Laboratory document an experiment using positrons to find clusters of four atomic vacancies at the surface of gold nanoparticles embedded in a magnesia matrix. These clusters of vacancies explain changes in the optical properties when the materials are subjected to different fabrication processes.

Positrons were generated by smashing gamma rays against a tungsten target. The gamma rays divide into negatively charged electrons and their antimatter, positrons. The decay of unstable sodium-22 provided an alternative source of positrons. The positrons are injected into the gold nanoparticles, and through advanced spectroscopy, the researchers are able to determine the size, location, and concentration of the vacancy clusters. According to the researchers, possible future applications for this work include higher-speed computer chips than available now, manipulation of the properties of optical devices, less brittle ceramic material than currently available, and improved fiber-composite materials than currently available.

Spray-on Skin of Polymer Fibers May Allow Wounds to Heal Without Scarring

Researchers at Electrosols, a biotechnology company based in Haslemere, Surrey, United Kingdom, have developed a spray that could help wounds heal without scarring. The spray produces a fine web of biodegradable polymer fibers that collagen-making cells called fibroblasts can grow on. As more and more fibroblasts grow on the polymer webbing, they produce a regular collagen structure, much like that in normal skin. Electrosols researcher Ron Coffee believes that controlling the formation of collagen in this way will lead to normal skin growth instead of scarring.

As reported in the January 8 issue of *New Scientist*, to make the spray, Coffee mixes ethanol and a biodegradable polymer—such as polylactic acid—in a small semiconducting container, and then gives it an electric charge by putting an electric field across the container. Because the wound is at a far lower electrical potential than the polymer, the solution is attracted to the skin surface and flies out through tiny nozzles, producing fine, light fibers, each of them 5 μm in diameter. The fibers have the same charge, so they repel each other, making them regularly spaced.

Other researchers are more cautious about the spray's prospects. Bruce Martin, a reconstructive surgeon at the University of Florida, said, "This initial polymer fiber mat wouldn't necessarily have any bearing on the final scar. Collagen is organized and reorganized continuously, and that's governed by a whole range of things."

When skin is punctured, the damage often destroys the weave-like structure of collagen that gives skin its strength. But when the body tries to patch up the wound the body creates a quick fix by producing thin, aligned strips of collagen. When skin cells grow on this, they produce the pale, less flexible material known as scar tissue, rather than normal skin.

Uniformity of Rocks at Lower Levels of Deep Boreholes May Facilitate Burial of Radioactive Waste

Fergus Gibb, a geologist at the University of Sheffield, United Kingdom, proposes that high level radioactive waste (HLW) should be disposed of in boreholes over 4 km deep. As reported in the January issue of the *Journal of the Geological Society*, special cylinders filled with HLW are placed in the lower section of the hole, which is then back-filled with crushed granite and sealed. The container's contents are designed to deliver the heat necessary to heat the waste and surrounding rock such that maximum temperatures of 800–900°C are generated at the container/rock interface. At these temperatures, the rock is changed in a series of fronts moving away from the container, followed, in the zone closest to the container, by partial melting. As the heat decays away, this partial melt solidifies, sealing the container and its con-

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