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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tents into a sarcophagus of solid granite. Beyond it lies the zone of metamorphosed rock, and beyond that, a final zone where hydration reactions will add a final barrier by plugging rock fractures. These zones constitute a multiple "near field" barrier, whereas the 4-km burial depth—much greater than that envisaged for conventional nuclear repository—constitutes the "far field" barrier.

Gibbs said that rocks are much more uniform at such great depth, liberating planners from the dictates of shallow geology, and thus greatly increases the choice of available sites. He said also that any intra-rock water present at these depths is stable, has been there for millions of years, and will not return to surface so long as the hole is adequately back-filled and sealed. Leakage of radionuclides from the sarcophagus would probably not matter since the waters present at such depths have not moved for millions of years. Very deep disposal of this sort also increases the likelihood of the containment surviving earthquakes.

Hybrid Process Uses Electromagnetic Force to Mold Aluminum Auto Parts

Glenn S. Daehn, professor of materials science and engineering at Ohio State University, and his colleagues at Ohio State and General Motors developed a process that combines traditional metal stamping with electromagnetic forming. In this hybrid technique, a tool stamps out the general shape of a part, and electromagnetic pulses help form details.

As Vincent J. Vohnout, a postdoctoral researcher in materials science and engineering, reported at the International Conference on Technology of Plasticity in Nuremberg, to keep the aluminum sheet from tearing, the researchers softened the shape of the tool, replacing sharp corners with gradual curves, and stamped the general shape of the part. They then turned to electromagnetic forming, and like-charged metal coils repel the metal into a mold. The researchers placed coils behind only the unfinished spots of the panel, and used electromagnetic force to

Biomechanics Meeting Presents Materials-Related Topics

Scientists at the 23rd Annual Meeting of the American Society of Biomechanics, held in October 1999 in Pittsburgh, presented materials-related issues involving polymers, surface treatment, and bone prostheses. In one presentation, by simulating the natural load on human thigh bones, scientists Michael H. Santare and Suresh G. Advani of the University of Delaware proposed a design for an artificial hip that would reduce stress-shielding and prevent bone atrophy. After they modeled the function of a healthy hip, Santare and Advani compared their findings with an analysis of the stress patterns produced by a conventional artificial hip and by the design pioneered by E. Munting and M. Verhelpen in 1995 in which a much shorter rod than previously used, attached to the top of the thigh by several small bolts, was inserted through the exterior side of the bone.

Santare and Advani's resulting design greatly reduced the prosthetic rod, which seems to be responsible for much of the rigidity and altered loading that occurs following hip replacement. In its place, they used a system of cables to fix the implant to the proximal femur. A platelike base is used to transfer the bending loads from the prosthesis to the bone. Santare said that further improvement can be achieved by using advanced composite materials to tailor the stiffness of the implant. While the design was still in prototype form during the conference, Santare said that mechanical tests using bone from a cadaver suggested the viability of this new technology.

To address the threat of aseptic loosening to the long-term success of cemented total hip stems, Keith T. Hustosky's research team at West Virginia University studied the pull-out loads and axial displacements of stems that differed only in surface roughness to determine the effects of surface finish on total hip-stem behavior. Using PMMA bone cement to insert tapered, collarless total hip stems into nine femora, the researchers tested seven specimens with a polished-surface finish and two with a matte-surface finish. They applied a tensile axial force to the stems through a pull-out fixture. With the mean pull-out load of 1238 N, the polished stems were extracted from the cement mantle without damaging the cement, bone, or fixture. The researchers were unable to pull the stems with a matte finish out of the cement without the femur fracturing. They reported a mean failure load of 6743 N.

When analyzing three stem-cement interface conditions—perfect bond, debonded with a friction coefficient of 0.22, and completely debonded—the researchers found that "the matte-finish specimens achieved a well-bonded stem-cement interface, while the polished specimens had debonded at the stem-cement interface with a friction coefficient less than 0.22." They reported that failure of the bone occurred before failure of the interfaces and cautioned that study of the pull-out strengths should not be the only means of evaluating total hip stems with different surface finishes.

Researchers at the Biomechanics Laboratory in the Minneapolis Sports Medicine Center and Cardiac Assist Technologies in Pittsburgh have determined that low-density polyurethane (LDPU) foam models can be used to characterize suture pull-through properties in bone. The researchers evaluated LDPU foam with a density of 0.24 g/cm^3 and high-density (HDPU) foam with a density of 0.48 g/cm^3, representing low, to mid-range density values for cancellous bone. They recorded failure mode and load-elongation data and compared these measurements with those gathered for a comparable study using ribs. The researchers concluded that given that suture pull-through is principally a concern in patients with lower-density cancellous bone, LDPU specimens should be used to assess the pull-through properties.

Researchers in Seoul from the Korea Institute of Science and Technology, Hansung University, Kyoung Hee University, and Hallym University determined that methodically coating a dental implant with a viscoelastic polymer can reproduce the periodontal ligament's function to absorb the shock of impact, reducing stress on the bone. The researchers coated implants with 50- and 100-μm layers of chitosan—similar to a periodontal ligament's thickness—then mechanically tested and compared initial stability between samples of coated and uncoated implants. They reported that "uncoated implants had an average shear stiffness of 34.728 kg/mm and the coated implants 47.108 kg/mm." They reported that the shear stiffness of a coated implant is increased by 35.64% because the material expanded, filling the gap between the implant and the alveolar bone during the implant operation.