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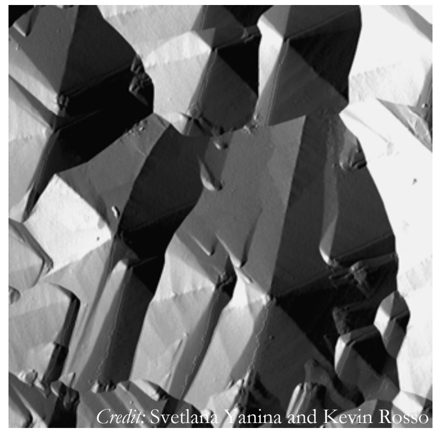
EMSL In Brief
Environmental Molecular Sciences Laboratory

Mineral Surfaces Linked by Electrons Through the Mineral's Bulk

If the Flintstones had electricity, their wires might have been made of rock. Results in *Science Express* [March 6, 2008] show that hematite can conduct electrons under certain chemical conditions. In addition, the current causes some mineral surfaces to build up while others degrade. These results with iron oxide might be important for water quality, soil evolution and environmental cleanup.



Iron building up into pyramids on one face of an Fe(III) oxide crystal sends electrons to another face, which slowly dissolves.

"Considering iron as an important nutrient, the finding could help us understand how soils evolve from nutrient rich to nutrient poor," says lead investigator Kevin Rosso, a frequent scientific user of the Department of Energy's Environmental Molecular Sciences Laboratory.

When Rosso and Pacific Northwest National Laboratory colleague Svetlana Yanina immersed a cube-shaped hematite crystal in an acid solution in the absence of oxygen, they expected all surfaces to degrade. But, they found one surface grew pyramid-like mounds rising from the top.

No one had previously reported this buildup, so the team modified their experiments to try to prevent the pyramids from growing. The researchers performed atomic force, scanning electron and transmission electron microscopy at EMSL, as well as electrical potential measurements of the individual surfaces to explore how the pyramids formed.

Because hematite is a crystal of iron oxide, the sides are structurally different, with different chemical properties. The team wondered if the iron being deposited on the top came from iron dissolving from the sides, building up in solution, and then redepositing. The team found that the breakdown and buildup were not independent, hinting at electron conduction. They found the iron in solution, Fe(II), which contains one more electron than the iron in the crystal, landed on the top of the cube, reacted with the surface, incorporated into the crystal and gave up its electron. Electrons flowed through the crystal to the sides, where Fe(III) atoms could pick up the electrons and dissolve into the solution. Additional experiments showed the electrical potential driving the current flow, which came out to 200 millivolts—about six percent of the power needed for a keychain LED light.

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