RARE-EARTH INFORMATION CENTER INSIGHT

Institute for Physical Research and Technology
Iowa State University / Ames, Iowa 50011-3020, U.S.A.

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New Superconducting Developments

Recent photoemission studies carried out by a team of scientists at four national Department of Energy laboratories (Los Alamos, Sandia, Argonne and Ames) show that the 1:2:3 superconductors are truly metallic in nature and not insulators as earlier measurements had indicated. These scientists used single crystals of $EuBa_2Cu_3O_{7-x}$ which were cleaved in a high vacuum at 20 K, exposing a fresh surface which was examined by synchrotron radiation. Analysis of the photoemission spectra clearly showed it to be metallic. When the clean surface is warmed oxygen is lost from the surface forming an insulating skin on the crystal. It is this insulating layer which others had observed in earlier photoemission studies.

This discovery means that theorists need to re-think their treatments of these 1:2:3 materials, also see below. On the practical side the formation of such an insulating film may present problems making useful superconductor - semiconductor interfaces.

About the same time as the above studies were disclosed, Japanese scientists [Y. Tokura et al., **Nature 337**, 345 (26 January 1989)] reported that when they doped R_2CuO_4, where R is a trivalent lanthanide, with Ce^{4+} the material become superconducting. This is the first evidence for the occurrence of superconductivity in ceramic oxide materials in which the current carriers are electrons (called n-type conductors, where n stands for negative). Previously when the R_2CuO_4 phases were doped with Sr^{2+} the materials became superconducting, but in this case the current carriers were holes (i.e. p-type conductors, where p stands for positive). This result will also give fresh thought for theorists. At the present time, however, the superconducting transition temperature of the n-type material is quite low, superconductivity appears to begin at 24 K.

Catalytic 1:2:3 Superconductors

If the superconducting market for the $YBa_2Cu_3O_{7-x}$ does not develop (or even if it does), perhaps these oxides may be important catalysts. In one paper H. Shimada et al. (**Chem. Lett. 1988**, 1797) found that the $YBa_2Cu_3O_{7-x}$ material supported on MgO had a higher catalytic activity for the decomposition of NO than commercial Pt supported catalysts at 800°C. X-ray photoemission studies suggest that the decomposition reaction is facilitated by the redox cycle of the Cu in the 1:2:3 phase. It appears that the Y-Ba-O

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Telephone: (515) 294-2272
Facsimile: (515) 294-3226
Telex: 269266
BITNET: RIC@ALISUVAX

framework provides a local structure that enables rapid and stable Cu redox cycle to occur at 700°C and higher.

In a second paper E. A. McNamara et al. [J. Chromatogr. 452, 75 (1988)] describe the use of $YBa_2Cu_3O_{7-x}$ phase to catalyze redox reactions between organic species and NO_2 in a chromatographic detector. The reactions were studied from 200 to 350°C at flow rates of 3.9 to 36.5 ml/min. The authors found that the 1:2:3 phase was particularly effective in the oxidation of alcohols in reactions with NO_2 to form NO.

New High Strength Amorphous Mg Alloy

The Japanese scientists who co-discovered the new high strength rare earth containing Al amorphous alloys (see the last issue of **RIC Insight**, "Follow-up - High Strength Glassy Alloys") now have found they are able to do the same thing with amorphous Mg alloys. [A. Inoue, et al. **Jap. J. Appl. Phys. 37** L2248 (1988)]. Inoue and co-workers found that a melt spun Mg alloy containing 10 at.% each Ce and Ni had a tensile fracture strength more than twice as large as conventional, optimum age-hardened, Mg-base crystalline alloys (750 vs. 300 MPa). The specific strength (the fracture strength divided by the density) had a value of 27, which is ~ 30% higher than the highest value (20) for commercial crystalline Al alloys. The recrystallization temperature for the $Mg_{80}Ce_{10}Ni_{10}$ alloy is ~ 200°C. The amorphous Mg alloys were also found to have good ductility.

Follow-up - Corrosion

In the March 1, 1988 issue of **RIC Insight** (Vol. 1, No. 1), we reported on the use of rare earths as inhibitors in aqueous corrosion and as coatings for corrosion protection. Since then the Australians, L. Wilson and B. R. W. Hinton, received a patent (PCT Int. Appl. WO 88 06,639, 7 September 1988) on coating Al, Al-base alloys, Zn, Cd, Mg, and steel with Ce^{3+} hydroxide peroxide. $CeCl_3$ is dissolved in an aqueous acidic bath to a concentration of 0.5 to 1.5%. The Ce in the solution is oxidized with H_2O_2 to form Ce^{4+} ions, and as the pH is increased to 2.7, the $Ce(OH)_3O{\cdot}OH$ precipitates out on the metal surface to be protected. The coating process is completed in about ten minutes at 50°C. As noted earlier the corrosion protection is as good or better than the current coatings, but the rare earths are environmentally much safer than the currently used materials.

MCI-Megon A/S and A/S Megon & Co. Combined

As of March 1, 1989 ELKEM of Norway and Mitsubishi Kasei Corporation of Japan have sold their interests in the MEGON group to Norsk Miljøteknologi AS, a Norwegian investment firm. As a result MCI-Megon A/S and A/S Megon & Co. have been brought together under the same name, MEGON AS. Mr. Per H. Dybwad is president of MEGON AS, one of the leading companies in the solvent extraction of rare earths, especially laser grade Y_2O_3 and Sc_2O_3.

Karl A. Gschneidner, Jr.

K. A. Gschneidner, Jr.
Editor and Director RIC