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Comments on Metallic Catalytic Converters

In the lead story in last month's issue of **RIC Insight**, "Ferritic RE Stainless Steel", we discussed the use of Alfa-IV, a new ferritic alloy for preheated metallic catalytic converters, and suggested that these would replace the ceramic ones for auto exhaust emission control. Dr. Barry T. Kilbourn, Molycorp (New York) pointed out that in the U.S.A. the electrically heated catalytic converters (EHCC) will be used as "an *extra* converter to reduce emissions during the first two minutes of cold start before the main ceramic converter has warmed up. Hence the need for quick electrical heating. As of now the catalyst composition for these EHCC's has not been detailed but will most probably resemble those compositions for the ceramic units. There are still significant doubts about the longevity of the proposed EHCC units." He continues, " in Europe there are more attempts to use the metallic converters as the prime converters, but I do not think they are widely used. In all cases the need for catalysts (Pt, Rh sometimes Pd, CeO_2, sometimes La_2O_3, and others) remains."

New High Temperature Superconductor Product Developments

One of the first electronic high temperature superconducting devices to go commercial is a SQUID (superconducting quantum interference device) system. The first complete SQUID system was reported to have been shipped in March 1992 by Conductus, Inc. of Sunnyvale, California. The SQUID is an extremely sensitive instrument for detecting and measuring magnetic fields. The initial use of the Conductus device is for undergraduate laboratories as an educational aid. The system, which is known as "Mr. SQUID", sells for $1,500 and includes a dewar flask, an electronic package and a user's manual. The heart of the system is a superconducting loop of Josephson junctions made of thin films of the $YBa_2Cu_3O_{7-x}$ superconductor. These SQUIDs have many potential applications such as monitoring brain activity, geological surveying, metal detectors, non-destructive evaluation, etc.

In a March 1992 news release, the Argonne National Laboratory announced the development and licensing of an electrical current lead incorporating the $YBa_2Cu_3O_{7-x}$ superconductor. The lead is composed of a proprietary blend of the $YBa_2Cu_3O_{7-x}$ ceramic and other materials which increase the strength and flexibility of the superconducting ceramic while maintaining its good superconducting properties. This lead replaces the normal metallic leads which carry the current between the normal room temperature conductors and the low temperature superconductors which operate at 4 K (liquid helium). The high temperature superconductor, which is non-resistive below liquid nitrogen temperatures (77 K), does not transfer as much heat as normal electrical leads do to the liquid helium bath, thus reducing the

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liquid helium boil-off and saving energy, which would normally be required to recycle the evaporated liquid helium. These superconducting leads would replace the current metallic electrical leads used in magnetic resonance imaging devices used in hospitals and magnets used in physics research. The largest potential market in the near future is the Superconducting Super Collider being built in Texas which will contain thousands of magnets made of the conventional low-temperature superconductors. Because a large critical field is not required in this application, the use of the $YBa_2Cu_3O_{7-x}$ superconductor should occur in the not-to-distant future.

Buckyballs

You may have been seeing a lot of things in the literature these days about the new polymorphic form of carbon: carbon clusters -- the most common one being C_{60}. A great deal of exciting science is being carried out on these materials, and even some practical things are being talked about, e.g. using buckyballs to grow diamond films. Rare earthers should keep their eyes open, since the rare earths are involved. One of the first buckyballs discovered {back in 1986, see **RIC News, 21**, [1], 2 (March, 1986)} contained a lanthanum atom rattling around inside the C_{60} cage. More recent work involved yttrium encapsulated in carbon clusters. These include $Y@C_{60}$ and $Y_2@C_{82}$, where the @ sign between the chemical symbols means that the first element (Y in this case) is enclosed inside the carbon cluster. Lanthanum clusters reported to date include $La@C_{44}$, $La@C_{60}$, $La@C_{82}$, $La_2@C_{66}$, $La_3@C_{88}$ and $La_4@C_{110}$. The last three, however, should not be called "balls" because they are tube shaped, holding the lanthanum atoms like peas in a pod. The name buckyballs is short for buckminsterfullerenes (or sometimes just called "fullerenes"). This name was given to the C_{60} clusters by the discoverer of these materials (Prof. Richard E. Smalley, Rice University, Houston, Texas) because they resembled some of the structures designed by the world famous architect, Buckminster Fuller.

Erbium-Doped Lithium Niobates Optic Devices

$LiNbO_3$ guided wave optics has produced one of the most sophisticated integrated optic structures to date, but so far the technology is unable to produce or amplify light, which is acceptable for optical communications and/or devices. Some bulk-grown Nd doped into $LiNbO_3$ ($Nd:LiNbO_3$) have been fabricated and both lasing and amplification have been demonstrated. The bulk-doped materials are not satisfactory because absorption will occur in every section of the waveguide which has not been pumped to transparency. Some attempts to locally dope $LiNbO_3$ with Er have been somewhat successful by ion implanting Er followed by a 45 hour anneal at 1050°C. Some success has also been achieved in obtaining a stimulated emission at 1.53 μm for an Er coated $LiNbO_3$ substrate after heat treating for 80 hours at 1060°. Recently, Gill et al. [**Appl. Phys. Lett. 60**, 1067 (1992)] have developed a process for producing locally doped $Er:LiNbO_3$ waveguides. These authors have increased the diffusivity of Er in $LiNbO_3$ by a factor of 15 by co-diffusing Ti with Er at 1050°C for 20 hours. The fluorescence spectra from the $Er:Ti:LiNbO_3$ material is nearly the same as that of the bulk doped $Er:LiNbO_3$. The authors also point out that $Er:Ti:LiNbO_3$ channel waveguide fabrication is compatible with the standard $Ti:LiNbO_3$ technology, and thus they have great expectations that their process will yield integrable guided wave optical amplifiers and light sources for $LiNbO_3$ based integrated optics.

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