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 Producer

A new rare earth plant is reported to be coming on stream in 1990. S.A. Mineracao de Trinidade (Samitri) is building a $15M plant in the southern part of the state of Minas Gerais to produce 2,000 metric tons per year of monazite along with 45,000 tons ilmenite and 5,000 tons zircon. Minas Gerais is one of the largest states in Brazil and is located north of Rio de Janeiro.

Prospective Producer

Carr Boyd Minerals Ltd. has released some information concerning the Mt. Weld rare earth project near Laverton, Western Australia. Drillings indicate that the Mt. Weld monazite ore body is probably the highest grade rare earth deposit in the world, with 15.4 million metric tons containing 11.2% rare earths, and 1.3 million tons of this 15.4 million tons containing 23.6%. Furthermore, this monazite has an exceptionally low thorium content and an unusually high yttrium content, running at ~4% of the total rare earth content (normal monazite contains ~2% yttrium). The monazite is reported to be less refractory than beach sand monazite, thus making it easier to recover the rare earths. If continued drillings and studies are favorable, there could be another Australian producer in the near future.

Room Temperature Oxygen Sensors

The common, commercially available oxygen sensors, which are based on stabilized zirconia (usually yttria stabilized zirconia) or oxide semiconductors, operate only at high temperatures. N. Miura and N. Yamazoe have developed, over the past few years, a room temperature, solid state, oxygen sensor using a LaF_3 single crystal as the electrolyte, Pt as the sensing electrode and Sn + SnF_2 as the counter electrode. One of the problems with this room temperature sensor was the long response time, up to 12 minutes, to obtain a valid oxygen concentration readings. Recently, these authors along with J. P. Lukaszewicz (the senior author) reported on using perovskite-type oxides instead of platinum as the sensing electrode [Jap. J. Appl. Phys. **28**, L711 (1989)]. Of the six oxides tested, $LaCrO_3$ and $LaCoO_3$ were found to be better sensing electrodes than platinum with higher sensitivities (by about 40%) and shorter response times (less than 5 minutes). It appears that a practical, room temperature, solid-state, oxygen sensor is coming closer to reality.

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

Rare Earth Air Conditioners

By the turn of the century, our homes, places of business, cars, etc. may be cooled by magnetic refrigerators containing various rare earth components. Today, the mechanical refrigerators/heat pumps that are used near room temperature are based on gas-cycle vapor-compression technology using chlorofluorocarbon (CFC) refrigerants. But with the banning of these CFC materials by most of the developed countries because of the destruction of the protective ozone layer above the earth by CFC, alternate refrigerants or alternate methods for heating and cooling are being examined. J. R. Hull and K. L. Uherka [Energy, 14, 177 (1989)] discuss the potential use of magnetic heat pumps/refrigerators as replacements for the mechanical systems.

With the discovery of the high temperature ceramic oxide superconductors, magnetic heat pumps/refrigerators are much more attractive since magnetic fields of 6 to 10 T (60 to 100 kOe) are required to make magnetic refrigerators competitive. If one can generate fields > 6 T at 77 K, the input power to refrigerate the superconducting magnets is reduced by a factor of 20 over the 4 K temperature required to operate the present day high field superconducting magnets. Currently the $YBa_2Cu_3O_{7-x}$ (1:2:3) superconductor is still the leading candidate because the 1:2:3 material still holds the record for the critical current (J_c) carrying capacity for the oxide superconductors. Improvements of a factor of 10 to 100 in J_c are still needed to obtain magnetic fields of 6 to 10 T. Furthermore, engineers will need to find ways to mechanically support the oxide superconductor wires or ribbons against the large forces generated by these magnetic fields.

Aside from the high field magnets, the rare earths are also prime candidates as the magnetic refrigerant, i.e. the working "fluid". For near room temperature applications, gadolinium metal is the choice material because it has a magnetic ordering temperature near room temperature and a large effective magnetic moment. Hull and Uherka estimate that 0.4 g gadolinium would be needed to produce 1 watt of cooling. Thus, if all of the present day U.S.A. industrial refrigeration ($\sim 10^{10}$ watts) utilized gadolinium metal, 4×10^6 kg would be needed. This is about 1/100 of the known world reserves.

A magnetic refrigerator works in the following way. When a magnetic field is applied, the magnetic moments in gadolinium line up and in an adiabatic system, the energy of magnetization is transferred to the lattice as thermal energy and the material heats up - just as when a gas is compressed in a CFC refrigerator. When the magnetic field is reduced to zero, the magnetic moments want to become disordered (unaligned) and in so doing, remove thermal energy from the lattice cooling the gadolinium metal - just as when the gas is expanded in a CFC refrigerator. The authors point out that several magnetic refrigerators have been built and tested. To date, the maximum temperature difference realized was 58°C in a system without an external load. At this stage, magnetic air conditioning looks promising.

Karl A. Gschneidner, Jr.

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