Rare-earth Information Center INSIGHT

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Rechargeable Hydride Batteries

The use of lanthanum in metal hydride - nickel hydroxide rechargeable batteries appears to be the next new major growth area for rare earths. This would indeed be welcome news since such an application would help to bring the utilization of the light lanthanides into better balance with production of the separated elements, which is currently out of balance because of the demand for neodymium in permanent magnets.

The idea of using a metal hydride (i.e. $LaNi_5$ or an alloy based on this 1 to 5 rare earth to transition metal ratio with the hexagonal $CaCu_5$ structure) was first mentioned about fifteen years ago. Essentially nothing appeared in the literature until 1984 when J. J. G. Willems published a comprehensive paper about his studies on the chemistry and physics of a rechargeable metal hydride battery and on the construction of such a cell [**Philips J. Res. 39**, Suppl. No. 1, 1 (1984)]. Since then a large number of papers on this topic have appeared, especially over the past two years. Most of the papers have been published by the Dutch group at Philips and by a number of Japanese institutions. One can rest assured that every battery manufacturer in the world, and many other organizations, are working on these materials.

The negative electrode (anode) is the hydrided $LaNi_5$-base alloy and when the battery operates, the hydrogen in the metal hydride is oxidized to H_2O and releases electrons to the external circuit. At the same time, the nickel oxyhydroxide positive electrode (cathode) is reduced to form nickel hydroxide. During the recharging cycle, the water is electrolyzed into hydrogen, which is absorbed by the $LaNi_5$-base alloy material, and hydroxyl ion, which oxidizes the nickel hydroxide to nickel oxyhydroxide. The metal hydride alloy is usually a complex alloy containing approximately equal amounts of nickel and cobalt for the transition metal, plus smaller amounts of aluminum and perhaps copper, chromium, manganese, titanium and silicon, and for the rare earth metal lanthanum, or mischmetal, or ~ 80% lanthanum - ~ 20% neodymium, and sometimes a small amount of zirconium. The alloying additions are added to improve the usable temperature range, long term cycle life, and charge retention, without too much adverse effect on the capacity of the battery. Some alloys have been reported to have lifetimes of over 4,000 charge-discharge cycles, retaining 84% of its initial capacity.

The metal hydride batteries are expected to replace the common nickel-cadmium (ni-cad) rechargeable batteries. The metal hydride batteries have

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many advantages over the latter: higher charging and discharging rates, higher energy densities (i.e. higher energy storage capacity per unit volume), no detrimental effects due to overcharging or overdischarging, longer lifetimes, and no memory effects. One major driving force is that the new batteries are environmentally safe, while the cadmium in the ni-cad batteries is of a great concern, especially when these batteries are disposed of - generally when discarded by the public they end up in land-fills and potentially could pollute the land and underground water supplies.

The ni-cad battery market is among the fastest growing areas in the battery field, with annual growth rates of up to 40%, with an estimated 1988 consumption of ~ 700 million batteries in the U.S.A., which is probably about 40% of the entire world market. To give one an idea of the impact of batteries on our lives - Mr. T. Ishibashi, President of the Japan Battery and Appliance Industry Association, estimated that the battery related industry contributes 11% to the GNP (gross national product) of Japan - similar fractions are probably valid for the U.S.A. and the European Community.

As this market develops it will probably keep prices of the other light lanthanides constant or from rising as fast as inflation. Although the future looks bright for the rare earths, there are other metal hydride alloys, which do not contain rare earths, which could offer considerable competition to the $LaNi_5$-based materials in this battery application.

Scandium Recovery

SX Holdings, Ltd. is expected to commence reprocessing of 200,000 tons of uranium tailings, which are especially rich in scandium, in Port Pirie, South Australia. The tailings are a result of uranium processing of the Radium Hill mine during the years 1955-1962.

SX Holdings is also expected to start the separation of yttrium from imported rare earths - which may seem rather incongruous considering the vast rare earth deposits in Australia. Actually, this is not as far-fetched as it sounds, since they are planning to extract rare earths from Australian sands containing monazite in the next few years, and with the yttrium separation plant in production, they can produce separated rare earths as soon as their monazite cracking plant is operational.

Applegate-REMACOR

The Applegate Group, Inc. and REMACOR jointly announced that Applegate will become the sales representatives for Reactive Metals & Alloys Corp. (REMACOR). Applegate formerly was the sales representative for Ronson Metals Corp. which shut down its mischmetal operations in June [see **RIC Insight** 3, No. 7 (July 1, 1990)]. The Applegate Group will market on behalf of REMACOR, which is the only mischmetal producer in the U.S.A., rare earth metals, silicides, and other rare earth alloys in addition to mischmetal.

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