Rare-earth Information Center INSIGHT

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19th Rare Earth Research Conference Highlights

The 19th Rare Earth Research Conference (RERC) was held in Lexington, Kentucky July 15-19, 1991. One of the featured sessions was on applied science and technology, in which the topics of the four invited papers dealt with an emerging or a potentially emerging market. These four papers covered: corrosion protection in aqueous environment with rare earth metal compound coatings - B. Hinton (Australia), high strength aluminum-rich metallic glass alloys - J. Poon (U.S.A.), active rare earth fluoride glass fibers - J. Lucas (France), and rechargeable nickel metal hydride batteries - T. Sakai (Japan). All four papers will be published in the Conference proceedings. In addition some details are presented below and more will appear in the October 1991 issue of **RIC Insight**.

Metal Hydride Rechargeable Batteries

T. Sakai (Government Industrial Research Institute, Osaka, Japan) described the state-of-the-art of nickel-rare earth metal hydride rechargeable batteries. Also see previous a **RIC Insight** (3 [12] (August 1990)) story on these batteries. The most promising alloy is a mischmetal (Mm), nickel, cobalt, aluminum alloy of the composition $Mm(Ni_{3.5}Co_{0.7}Al_{0.8})$ although a second alloy of the composition $Mm(Ni_{3.5}Co_{0.8}Al_{0.3}Mn_{0.4})$ is also of interest to battery manufacturers. The latter, however, needs an additional heat treating step before it can be used as one of the electrode materials in the battery. Dr. Sakai reported that two Japanese battery manufacturers (Matsushita and Sanyo) are already producing 400,000 rare earth-nickel hydride batteries per month, and Toshiba is at the 100,000 per month level. Other Japanese manufacturers are expected to start in the near future. These rare earth batteries are replacing the rechargeable Ni-Cd batteries. In 1990, 684 million Ni-Cd batteries were produced in Japan, 62% of the worldwide 1.1 billion production. The main reasons for the switch from Ni-Cd batteries to mischmetal nickel rechargeable batteries are that (1) the price of cadmium increased rapidly as this battery market grew, (2) the toxic nature of cadmium, which is of a real concern as people discard them after their useful life is completed, and (3) the higher storage capacity and better overall performance characteristics of the Mm-Ni batteries relative to the Ni-Cd batteries. For the rare earth batteries, because of the large production capacity and very large reserves of rare earth materials, most battery manufacturers expect the mischmetal price to remain fairly stable compared to the tripling of the price of Cd between 1987 and 1988; and finally the rare earths are not toxic and disposal of spent

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batteries will not be an environmental concern. At a level of 100 million batteries per year Sakai has estimated that 1,000 mt of alloy are needed, of which about one-third by weight is mischmetal.

The battery manufacturers, however, also have their eyes on replacing the lead-acid batteries found on most motor vehicles around the world. Again, here environmental concerns play an important role, because of the toxic nature of lead. But in this case, at least in the U.S.A., lead-acid batteries must be recycled and by law are not allowed to be discarded in landfills. In this case the Mm-Ni batteries must clearly demonstrate improved performance over the lead-acid batteries. In the next ten years because of exhaust emissions from gasoline and diesel powered vehicles, the state of California has mandated in 1998, that 2% of the cars sold in California must either be an electric car or operate on hydrogen, and by the year 2003, 10% of the cars need to be electric or hydrogen powered. Sakai has estimated that if 20,000 small electric cars were produced, each using a 400 Ampere hour, 48 volt battery, 3000 mt of mischmetal alloy would be needed. Potentially this could shape up to a real large market in addition to the replacement of the Ni-Cd batteries.

Battery Grade Mischmetal

Tricoastal Lanthanides Company recently announced the availability of a high purity grade of mischmetal, which is imported from Baotou, People's Republic of China. Most of the non-rare earth impurities in this grade of metal, which is called "battery grade", are considerably lower than those found in the regular metallurgical grade mischmetal. But the price of the battery grade metal is 35 to 80 percent higher than the regular mischmetal material. The Baotou plant has a capacity to produce 210 mt of the battery grade mischmetal per year.

Low-loss Frictional Superconducting Magnetic Bearing

Scientists and engineers at United Technologies Research Center (UTRC) and Argonne National Laboratory (ANL) have developed a flywheel with a superconducting magnetic bearing. The bearing is made from the $YBa_2Cu_3O_{7-x}$ (1:2:3) superconductor and the magnetic rotor is a SmCo permanent magnet alloy. The measured drag-to-lift ratio (a measure of the friction) was $4x10^{-6}$ for a flywheel spinning at 200,000 rpm at 77 K. This low drag-to-lift ratio is about 25 times better than the best values achieved for conventional magnetic bearings, $\sim10^{-4}$.

UTRC and ANL are working on developing such flywheels for energy storage. Until this development, flywheels were not efficient energy storage devices because of high bearing friction. The 1:2:3 - SmCo bearing is sufficiently friction free that only 0.1% of the energy stored would be lost in one hour - which is sufficiently efficient that the use of flywheels for long term energy storage becomes a viable possibility.

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