Rare-earth Information Center INSIGHT

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Gadolinium Imaging Agents

Magnetic resonance imaging (MRI) is one of the important diagnostic tools used by the medical profession for examination of patients for a variety of medical problems or illnesses. The signal intensity observed in MRI depends upon the proton spin density, relaxation rates and flow through the body. The signal contrast can be altered by injecting a drug or a "contrast agent" into the patient. The contrast agent alters the signal intensity of one particular region of the image. The contrast agents are typically paramagnetic metal-ion complexes which may concentrate in a tissue because of poor flow, or it may be tissue- or cell-specific because of a particular chemical property of the agent. The most important contrast agent is Gd-DTPA (DTPA = diethylenetriaminepentaacetic acid). Gadolinium is especially effective since it has the highest spin-only magnetic moment, and because its complexes (especially DTPA) have labile water molecules. The Gd-DTPA complex must be, in addition to being water soluble, stable for 2 years in vitro and at least a day in vivo until excreted, resistant to substitution of the Gd ion, and enhance the relaxation of the water protons. The dosage rate is about 0.1 m mole Gd per kilogram of body weight (i.e. ~1g Gd_2O_3 per dose). In 1990 the MRI contrast agents market was $100 million, and it is expected to grow by a factor of ten by 1995 (a 60% annual growth rate). It has been estimated that in 1990 about one million doses of Gd-DTPA or other Gd complexes were injected into patients. An important use of the Gd imaging agents is for cranial MRI, but it is also used to detect spinal tumors, tongue carcinoma, active from inactive multiple sclerosis, and examination of the upper and lower abdomen and stomach.

Rare Earth-Aluminum Alloys

What is one of the fastest growing markets in China? Yes, you guessed it from the title -- rare earth aluminum alloys. According to D.-X. Tang et al. [***J. Rare Earths,*** **10**, 66 (1992)] the use of rare earths in aluminum grew from 12,000 to 120,000 metric tons in just six years (from 1983 to 1989) - a growth rate of over 45% per year. By 1989, 16% of the aluminum produced in China contained rare earths. The big breakthrough occurred in the early 1980's when the Chinese found that rare earths could be introduced into the aluminum during the electrowinning process where the rare earth compound (usually R_2O_3) is co-reduced with the aluminum to produce the rare earth-aluminum alloy. The authors note that it is unnecessary to alter the current equipment and the process that is already in use. The rare earths help to reduce hydrogen, oxygen, sulfur and other tramp elements in the aluminum, thus greatly improving thermoplastic properties, heat resistance and corrosion resistance of aluminum alloys. The rare earth-aluminum alloys are used in Al-Si alloys for pistons and cylinders in internal combustion engines,

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heat resistant cast alloys, electrical resistance, heating wires, hot-dip corrosion resistant coatings for steel, soldering alloys, electrical transmission wires, cookware, aluminum foil, capacitor plates, architectural alloys, and high strength alloys.

As far as we are aware, the amount of rare earths used in aluminum-base alloys in the USA, Europe and Japan is minuscule. If the major aluminum producers in the world find it is beneficial to add rare earths to aluminum, this could be a boon for the rare earth industry. Could it be that the quality of the raw materials and the control processes that the non-Chinese producers use yield an aluminum product such that improvements due to the rare earth additions are so small it is not economical to add them?

Ugimag Upgrades Its Valparaiso Facility

Ugimag, Inc.'s permanent magnet manufacturing plant has been modernized to provide a better and more consistent product. A new powder handling system which protects the raw material from oxidation and contamination, advanced materials processing equipment to produce corrosion-resistant magnets, and new process control instruments were installed at their Valparaiso, Indiana (southeast of Chicago, Illinois) plant.

A few months earlier they announced that they had developed a new Nd-Fe-B magnetic material which could operate at 180°C and which has a much improved corrosion resistance. They claim that the application life times of their magnets have been extended by orders of magnitude in aggressive environments.

Erbia Improves Ferrites

Soft magnetic ferrites are used on core materials for transformers, inductors, and magnetic heads for VCR's and audio tape decks. In addition to their soft magnetic properties, they have low core losses in high frequencies, and have good wear resistance because of their high hardness. The latter is especially important for head materials for magnetic recordings. The main disadvantage of the ferrites is their low saturation magnetization, which results in a lower degree of performance for transformers and inductors, and a lower density of magnetic records, as compared to metallic magnetic materials. Recently T. Mizushima et al. [***Mater. Trans., JIM*, 32**, 1177 (1991)] found that when Er_2O_3 was added to a $Mn_{0.54}Zn_{0.36}Fe_{2.10}O_4$ single crystal the saturation magnetization and permeability were increased with an optimum Er_2O_3 concentration of 0.05 mol %. The authors expect that the Er_2O_3 doped Mn-Zr ferrites will be used in magnetic head materials for VCR's where the highest degree of performance and highest density of magnetic recordings are required. If the improvements noted by the authors hold-up, it is quite likely that consumers will demand the better performance materials, and this development could be a significant market for erbium. One wonders how the other heavy magnetic lanthanide oxides would work relative to that of erbia! I am sure this avenue is being pursued, if not it will be shortly.

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