

Rare-earth Information Center

Insight

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Review of Mechanical Alloying of Intermetallics

Mechanical alloying (MA), the synthesis of materials by high energy ball milling of powders, has been around since the late 1960's when it was developed in order to produce oxide-dispersion-strengthened alloys. More recently, the interest in MA has focused on the nonequilibrium nature of the processing method which was inspired by the discovery that amorphous alloys could be produced by this process. Mechanical alloying describes the process when dissimilar powders are ball milled together and Mechanical milling (MM), where single composition powders are processed to produce non-equilibrium structures, is the focus of an interesting review by C. C. Koch and J. D. Whittenberger (*Intermetallics*, **4**, 339-355 (1996)). The review covers the application of MA and MM to the production of intermetallics.

Cemented Carbides

Xiong Ji *et al.* (*Mat. Sci. and Eng.*, **A209**, 287-293 (1996)) report on the use of rare earth additives to cemented carbide for use in inserts, drawing dies and mining tools. The exact form of the additive is not reported but given as "a new type of RE additive". The addition of RE additives is reported to reduce the friction coefficients with respect to RE free alloys. The impurities in the RE containing alloys were concentrated in spherical inclusions of 0.5 μm diameter, as opposed to the rare earth free materials where the impurities concentrated in the alloy interfacial areas. The RE additions also decreased the sintering temperature and decreased the total porosity. The addition of RE was found to allow a reduction in Co content resulting in decreased production costs.

Long Phosphorescent Phosphor

A new phosphor with phosphorescence of sufficient intensity and duration that it can be perceived "almost through the entire night" has been reported by T. Matsuzawa *et al.* (*J. Electrochem. Soc.*, **143**, 2670-2673 (1996)). The new phosphor, $\text{SrAl}_2\text{O}_4(\text{Eu}^{2+}, \text{Dy}^{3+})$ is based on the green phosphor $\text{SrAl}_2\text{O}_4:\text{Eu}^{2+}$ which was investigated in the 1960's and early 1970's for lamp and CRT applications. This phosphor exhibits an initial rapid decay followed by a long persistence at a very low light level. The long persistence was attributed to the trapping of conduction holes. The phosphorescence mechanism is believed to result from the following sequence. When a UV photon excites the $4f-5d$ Eu^{2+} transition, a hole is produced at the $4f$ ground level and released thermally into the conduction band. Under normal conditions, the hole migrates for a short period before recombining with an excited Eu^{2+} ion. When a RE^{3+} ion is present in the structure, it creates a trap which captures the hole preventing it from recombining immediately. The trapped holes serve as an energy reservoir. Energy is released from this reservoir when holes escape by thermal activation and subsequently recombine resulting in the emission of light. Since the rate at which holes escape from the traps is a function of the temperature and

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the depth of the trap, both the intensity of the phosphorescence and its duration are determined by the trap depth. Hence, the proper choice of trap depth results in an appropriate compromise between intensity and duration of the phosphorescence. The depth of the trap is controlled by varying the RE^{3+} ion. For the green phosphor $SrAl_2O_4:Eu^{2+}$, dysprosium creates an appropriate trap while for the blue phosphor $CaAl_2O_4:Eu^{2+}$, neodymium is the ion of choice.

Microencapsulated Metal Hydrides

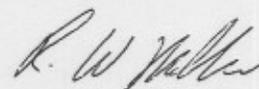
Metal hydride electrodes for nickel/metal hydride batteries operate in an aggressively basic solution which can result in corrosion of the electrode and failure of the cell. In order to address this problem, various surface coating methods have been applied to the metal hydride powders. Conventional electroless plating has been successfully applied to these materials but the complexity of the activation process and the instability of the solutions required have made this process commercially unattractive. H. H. Law *et al.* {*J. Electrochem. Soc.*, **143**, 2596-2600 (1996)} have developed a novel electroless process where the required reducing agent is the H stored in the metal hydride. Since the reducing agent is not present in the plating solution, the solution is inherently stable and does not require the inclusion of stabilizing agents. Since reduction requires that H diffuse through the metal coating as it forms, the coating thickness is self regulating. Finally since the reduction simply involves removing a metal oxide from the solution and producing water, the solution may be replenished by the simple addition of more metal oxide.

Preparation of Nanocrystalline Ceria

The use of ultrafine ceria powders with uniform particle size distribution for polishing agents, luminous materials and catalysts is wide spread. In the normal production route, hydroxides are precipitated from cerium salts using ammonia. Wang Chegyun *et al.* {*Mat. Sci. Eng.*, **B39**, 160-162 (1996)} present an alternative in their development of a hydrothermal technique carried out at 130°C and using ethanol as a solvent. The hydrothermal process is claimed to have a significant advantage over other processes in terms of energy consumption. Low aggregation and high purity are also claimed for the process. Moderate pressures ranging from 1.5 to 11.4 atm are used in the process depending on the exact solvent used.

Industry Notes

Advanced Material Resources Ltd. (Toronto, Canada) has announced the formation of a permanent magnet alloy subsidiary. Magnet alloys will be manufactured by the new subsidiary at AMR's joint venture in China. AMR announced that a minority position in the company will be held by Dr. John Croat who will direct the activity. John is well known to the rare earth community as one of the original inventors of the Nd-Fe-B magnet. *Etrema Products* (Ames, IA USA) has announced plans to continue expansion through 2001 adding 90,000 square feet to its facilities in that period. *Etrema* is best known for its production of TERFENOL-D magnetostrictive material. *Indian Rare Earths Ltd.* (Bombay, India) has been awarded ISO 9002 status for the manufacture and sale of commercial grade compounds. *Rhône-Poulenc* (Paris, France) has announced the commercialization of NEOLOR, cerium sulfide-based red and orange-colored inorganic pigments for coloring plastics. The pigments replace cadmium- and lead-based pigments.



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