Rare-earth Information Center

Insight

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Al_2O_3/YAG Eutectic Composite

In order to improve thermal efficiency, engines are being designed to operate at higher and higher temperatures. For jet aircraft engines and high-efficiency power-generation gas turbines, these temperatures are pushing the limits of available materials. Ceramic turbine materials such as SiC and Si_3N_4 are currently being investigated on a global scale but these materials tend to oxidize in ambient atmospheres above 1500 °C. Oxide ceramics clearly are resistant to oxidation but sintered oxide ceramics are susceptible to plastic deformation at high temperatures and hence can not be used as structural materials in high temperature applications. Single crystal oxides tend to be very brittle and hence are not suitable. Recently, Y. Waku et al {*J. Mat Sci.*, **33**, 1217-1225 (1998)} have reported the successful production of a single-crystal Al_2O_3/single-crystal $Y_3Al_5O_{12}$ (YAG) eutectic composite 40 mm in diameter and 70mm in length. The sample was free from colonies or pores. The sample was produced from Al_2O_3 YAG eutectic melt using the Bridgman method. The unidirectional solidification of the eutectic melt produced two intergrown single crystals with a typical intergrowth dimension of tens of µm. The eutectic composite is reported to consist of a <110> single-crystal Al_2O_3 phase and a <743> YAG phase without grain boundaries. Presumably the crystals are epitaxial though that is not stated. Superior high-temperature strength with no temperature dependence to the flexural strength is reported for temperatures to 1800 °C. The microstructure of the composite was stable with no evidence of grain growth during extended air anneals at 1700 °C. The lack of amorphous material on the interface between phases is credited for the superior performance.

$Tb_yDy_{1-y}Fe_2$ with Al or Mn additions.

$Tb_yDy_{1-y}Fe_2$, produced commercially as Terfenol-D® exhibits giant magnetostriction and low magnetocrystalline anisotropy. There has been considerable work on substitutions into $Tb_yDy_{1-y}Fe_2$ in order to reduce the magnetic field required to saturate the material. J. Du et. al. {*Appl. Phys. Lett* **72** 489-491 (1998)} have recently reported measurements on twin-free single crystals of $Tb_yDy_{1-y}Fe_2$ with Al or Mn additions. Since $Tb_yDy_{1-y}Fe_2$ is by nature anisotropic, crystallographic alignment is required for maximum magnetostriction. Grain boundaries and to a certain extent twin boundaries pin domain walls. Therefore in order to obtain the maximum magnetostriction at the lowest field, twin-free single crystals are desired. The compositions investigated were $Tb_{0.27}Dy_{0.73}(Fe_{1-x}Al_x)_2$ and $Tb_{0.5}Dy_{0.5}(Fe_{1-x}Mn_x)_2$. The x=0 values of the magnetostriction at 3 kOe were 1600 ppm and 815 ppm for the Al and Mn respectively. For the Al substitution, the saturation field decreases from 1.1 kOe to 500 Oe when x was increased to 0.15. This was accompanied by a decrease in the magnetostriction to about 400 ppm. For the Mn substitution 3 kOe was insufficient to saturate the x=0 composition while the x=0.1 composition saturated at 600 Oe. Again a significant reduction in the magnetostriction was observed with a value of about 200 ppm for the x=0.1 material.

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Solidification Science and Engineering Practice.

While not dealing directly with rare earth metals, a review article by M. C. Flemings {*MRS Bulletin* 30-36 (May 1998)} covers the basics of solidification, which should be of interest to anyone casting alloys. The article is the edited transcript of the 1997 David Turnbull Lecture presented by Flemings at the 1997 MRS Fall meeting. The article covers dendrite formation, dendrite arm spacing, macro segregation, directional solidification, and rapid solidification. As it is aimed at a general audience, it is easily accessible to the non-metallurgist.

Amorphous Metals in Electric-Power Distribution Applications

Another general interest article is by N. DeCristofaro {*MRS Bulletin* 50-36 (May 1998)}. This article covers the development history of amorphous magnetic materials used in power transformers. Starting with the discovery of amorphous metals, the article covers the development of rapid solidification processing. For those of us who think we are doing state of the art processing with chill block melt spinning, it is interesting to note that E. M. Lang used the process to produce solder wire in 1871. Allow development for electrical power applications, transformer technology and economics are covered in the article.

Cleavage of DNA by Ln3+ Catalysts

A. Roigk et. al. {*Inorg. Chem* **37**, 751-756 (1998)} report on the use of lanthanides as catalysts for the cleavage of DNA. Apparently the lanthanides are very effective catalysts and I refer the interested reader to the original paper as I am not conversant in supercoiled plasmid DNA pBR322 form RF I.

YBM

Last month we reported that trading on YBM stock had been halted. The legal problems of this major producer of permanent magnets have continued to evolve. Reports in numerous newspapers have documented problems associated with a former major shareholder Semion Mogilevitch. Mr. Mogilevitch has been accused by police in at least six countries of heading an extensive crime syndicate. He and five associates owned slightly less than one-third of YBM Magnex International Inc.'s shares shortly after it went public in 1995. YBM states that Mr. Mogilevitch "never exercised control over the company and never had any involvement in management". To the best of our knowledge, the on going legal problems have not impacted YBM's ability to supply high quality magnets.

Happy Anniversary Treibacher

In 1898 Carl Auer von Welsbach founded Treibacker Chemische Werke AG in Treibach, Austria. The company, now Treibacher Industrie AG is celebrating its 100th anniversary. For more information see the June 1, 1998 *RIC News*.

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