Rare-earth Information Center INSIGHT

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Ceramists Attain the Holy Grail!

Ceramists have been searching for ductile ceramics for what has seemed like eons, but until recently it looked like the impossible dream. About two months ago, B. R. Lawn, *et al.* [**Science 263**, 1114 (February 25, 1994)] reported on some significant advances in achieving some "ductility" in silicon carbide (SiC) and a micaceous glass-ceramic. In the former case, a rare earth material, specifically yttrium aluminum garnet (YAG), plays the critical role in improving the ductility of SiC. The authors developed a heterogenous SiC alloy by adding YAG as a sintering agent, and subjecting the SiC-YAG material to a grain-growth heat treatment. The heat treated material had SiC grains ~ 3 μm thick and 25 μm long with weakened YAG interfaces between the matrix grains. The microstructural conditions were conducive to grain bridging which enhanced long-crack toughness. An indentation stress-strain curve tended toward a "yield" response, which is characteristic of a ductile solid, and differs with the elastic-brittle behavior exhibited by the SiC control material which did not contain the YAG additive.

The authors note that the ductility in the ceramic material is different from the dislocation process that operates in metals. Instead, the deformation originates at "shear faults" in the grain microstructure. The critical feature is the existence of intrinsically weak interfaces to create and arrest faults, and perhaps to provide paths for the ensuing extensile microcracks at the fault edges within the subsurface stress field. In the SiC-YAG material the shear faults form at the interfaces between the SiC matrix grains and the YAG grain boundary phases.

These ductile ceramics are especially germane to conditions where highly localized mechanical or thermal stresses are likely, i.e. in bearings, local impact conditions, refractories, and medical implants, such as tooth restoratives. This development could result in a potentially large rare earth market in 5 to 10 years, if YAG or some other rare earth sintering agent remains the material of choice as the ductility causing agent. In addition to SiC there are many other structural ceramics, [i.e. stabilized ZrO_2 (which already uses rare earths, especially Y_2O_3), Si_3N_4 etc.], which may be similarly affected.

E-lamps Become Available

General Electric Company's new E-lamps have just become available in Europe and are expected to be on sale in the USA before the end of the year. The bulbs are known as E-lamps because they use electronic controls. The new bulb has no filaments as an ordinary incandescent lamp, nor electrodes as in a common fluorescent lamp. The electronic components convert the ordinary 110 or 220 V household current into a high-frequency power which excites the gas in the bulb to generate ultraviolet (uv) light. A rare earth phosphor coating inside the bulb

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converts the uv light to visible light, similar to the way the phosphor works in the common fluorescent light. The red rare earth phosphor is $Y_2O_3{:}Eu^{3+}$ and the green one is $LaPO_4{:}Ce^{3+},Tb^{3+}$. The new E-lamps look much like the common incandescent bulbs, but are more efficient and have a much longer lifetime. The E-lamps produce about the equivalent amount of light as a 75 watt incandescent lamp, but only consume 23 watts of electrical power. The expected lifetime of the E-lamp is about seven years, about ten times longer than that of an ordinary light bulb. The expected USA retail price is about $20.00. The first uses are in commercial areas where the cost of changing bulbs is substantial. Household sizes are expected to be in production at a later date. The new bulbs are manufactured in Nagykaniza, Hungary.

This development should lead to an increased use of rare earth phosphors, because the E-lamps will primarily replace incandescent lamps, since they can be used in pre-existing fixtures. The fluorescent lamp market should not be affected too much by this new introduction (both the E-lamps and fluorescent lamps use rare earth phosphors). In addition, other factors which should help expand the rare earth phosphor market are: better color rendering possibilities, government energy efficiency regulations, and the more extreme environment inside the lamp.

Non-liquid Helium 6T Superconducting Magnet

Toshiba recently announced that they had built a prototype superconducting magnet which operates at 4K without using liquid helium to cool the system to 4K. The Toshiba unit uses a two stage Gifford-McMahon (GM) refrigerator, which has an Er_3Ni low temperature stage, to cool the magnet and environment to 4K and to maintain this temperature while operating the superconducting magnet at 6T. A 180 mm diameter Nb-Ti superconductor coil is powered to generate the 6T field. A Bi-oxide superconductor is used as the lead wire to supply the current to the magnet. Toshiba expects to commercialize these magnets in a few years.

Yttrium Oxide Paints

ZYP Coatings, Inc. announced the introduction of a new line of yttrium oxide (Y_2O_3) paints, which will stop interactions between reactive materials at high temperatures. The large heat of formation of Y_2O_3 makes yttria paints a prime material for coating crucibles and/or molds to serve as a reaction barrier between the crucible or mold and the reactive molten metals. The yttria paint can also be used as a mask for welding and brazing, or as a high temperature lubrication/release material in superplastic forming, or diffusion bonding or hot pressing operations. The yttria oxide paints have been available for some time, but a recent reformulation permits its use in these new applications.

Another Rare Earth Producer Meets ISO-9002 Standards

The General Electric Lighting's Chemical Products Plant in Cleveland, Ohio achieved this high distinction in late January 1994 for the production of rare earth halophosphors for fluorescent lamps. Congratulations on attaining this high level of quality assurance. The ISO-9002 standard requires that the GE Chemical Products Plant's products meet or exceed various criteria in 18 different activities.

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