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New Giant Magnetostrictive Alloy

Scientists from three organizations successfully demonstrated the operation of a low-frequency magnetostrictive acoustic transducer using a new lanthanide magnetostrictive alloy, $Tb_{0.6}Dy_{0.4}$. The new alloy has a magnetostriction which is about three times larger than that of Terfenol-D, but because of its low Curie temperature of 215 K, it must be operated around liquid N_2 temperatures (77 K). Since this alloy is activated by using one of the high temperature ceramic superconducting materials, which must operate around 50 K, both the Tb-Dy alloy and the superconductor are cooled together by using a Stirling-cycle cryocooler. The high temperature superconductor (HTS) in this case was $Bi_2Sr_2Ca_2Cu_3O_x$ which was used to provide at 0.1 T magnetic field at 50 K. Two HTS coils were used to generate an ac field, which was superimposed on a dc bias field which causes an oscillatory strain on the Tb-Dy magnetostrictive rod. A high power acoustic output was obtained at resonance frequencies of 520 Hz in air and 430 Hz underwater. The scientific team of C. H. Joshi and V. P. Voccio (American Superconductor Corp., Westborough, MA), J. F. Lindberg (Naval Undersea Warfare Center, New London, CT) and A. E. Clark (Naval Surface Weapons Center, Silver Spring, MD) reported their results at the Cryogenic Engineering Conference in Albuquerque, New Mexico, July 12-16, 1993. This paper will be published in **Advances in Cryogenics** next year.

The $Tb_{0.6}Dy_{0.4}$ alloy was used in the form of large orientated strips, which were prepared as follows. The arc-melted ingot was hot rolled at 550°C for a 25-fold reduction in thickness, followed by cold rolling for a 40% reduction, and a final heat treatment at 1000°C to relieve the stresses and allow some grain growth. After this processing, the grains were about 2 mm in cross section and the c-axis was within 5° of the normal to the rolled surface. These sheets were consolidated into rods 150 mm long with a square cross-section of 15 mm x 15 mm for transducer elements. The magnetostrictions achieved were > 0.4%, about 65% of that obtainable from a single crystal bulk alloy. The major problem with the Tb-Dy alloy is its ductility, which limits its ability to do work.

Acoustic transducers are used for underwater detection and navigation, ocean mapping, monitoring ocean currents, measurement of temperature and salinity gradients, and oil exploration.

Fluorinated Permanent Magnets

German scientists, M. Fähnle and T. Beuerle, carried out band structure calculations to see which interstitial atom would give the optimum magnetic properties in the R_2Fe_{17}-base

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permanent magnet materials. They found fluorine would increase the interatomic distances between the Fe atoms (just as nitrogen has been demonstrated to do experimentally) and thus lead to high Curie temperatures. They noted that the strong electronegativity of fluorine could induce a highly aspherical valence charge density around the lanthanide atom, which would result in an increase in the magnetocrystalline anisotropy. They predict that fluorine should be better than nitrogen or carbon in improving the permanent magnetic properties of R_2Fe_{17} materials. Their analysis was presented in **Phys. Stat. Solidi (b), 177**, K95 (1993). It will be interesting to see if their prediction holds up.

Lanthanum Aids Lithium Batteries?

Scientists and engineers who are involved in the development of solid state lithium batteries are continuously on the lookout for solid state compounds with a high lithium ionic conductivity. Recently, a group of Japanese scientists from the Tokyo Institute of Technology, headed by Y. Inaguma, report on the high ionic conductivity in $Li_{0.34}La_{0.51}TiO_{2.94}$ (LLT). They report that this compound has an ionic conductivity greater than 2×10^{-5} S/cm^{-1}, which is slightly lower than that of the standard prototype compound $Li_{3.5}V_{0.5}Ge_{0.5}O_4$, which has the highest reported room temperature conductivity of 5×10^{-5} S/cm^{-1}. The authors found that lithium will react with LLT to form an electron carrier. This is accomplished by the reduction of the titanium ion when the lithium is inserted into a vacant site in this perovskite phase. Thus, the Li-doped LLT now is a mixed conductor, and the authors suggest it is possible that it may be used as a cathode material for lithium batteries. However, a lot more research on this Li-doped LLT base material is necessary to improve its properties, so it will be utilized in lithium batteries.

Room Temperature Erbium Green Emitting Laser

An international scientific team from the Institut für Laser-Physik, Universität Hamburg, Germany, and the Center for Research in Electro Optics and Lasers, University of Central Florida, Orlando, Florida, USA claims to have been the first to produce a green laser emission from an erbium laser at room temperature. Prior to this work, green laser emissions from Er laser materials were only obtained at cryogenic temperatures, which severely restricts the number of applications for a laser operating at this wavelength. A $LiYF_3$ crystal doped with 1% Er was pumped with a pulsed dye laser at 486 nm and emitted a green light at 551 nm. A threshold of 75 μJ was required to start the laser emission. The Er:$LiYF_3$ laser operates at an efficiency of 6%. The details of this study by R. Brede *et al.* were published in **Appl. Phys. Lett. 63**, 729 (1993).

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