Rare-earth Information Center INSIGHT

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Volume 4 | November 1, 1991 | No. 11

S-I-L-E-N-C-E! The Roar of Rare Earths

You won't hear 'em, but they'll be there improving our quality of life -- the rare earths. In our modern society the roar of cars and airplanes, the rumble of trains and trucks, the whine of an engine, the racket of industrial machinery, the background din of refrigerators, heating and cooling systems have become one of our top occupational and environmental health problems. Rare earths, along with fast computer chips and powerful programming algorithms are going to be even making more noise, and as a result, paradoxically, the world will be a much quieter and pleasant place to live. In the USA over $1 billion is spent to control noise in the work place and as noise control regulations become stricter this figure could rise exponentially. One of the most promising technologies -- which is already commercially viable -- is active noise control (ANC). ANC does not mask out nasty sounds with pleasant ones. Nor does it muffle noise by soundproofing as most systems on the market do. Instead it cancels out sound with sound, by generating sound waves which are equal in amplitude and frequency, but completely out of phase with the noise one wishes to reduce or eliminate, and when the two oppositely phased sound waves collide -- silence is the result. The basic idea of ANC is not new -- it was demonstrated about 120 years ago by Lord Rayleigh. In theory ANC is simple, but in practice it is a complex and difficult problem.

The main problem is to analyze the complex mixture of sound frequencies of the noise and then to generate an exact mirror image of each component. Today powerful low cost digital sound processors can convert analog sounds into digital signals, and then analyze the signals, all on one computer chip. The ANC system consists of two microphones and one or more speakers, along with the digital processor. The first microphone picks up the noise near its source and feeds the signals into the processor. In addition to analyzing the signals, the processor is programmed to predict how the characteristics of the sound will change as it travels away from the source toward the ears of the person who would hear the noise. The computer then generates the appropriate "anti noise" which is broadcasted from the speaker(s) which are located away from the first microphone. A second microphone which is located near the speaker provides an error correction feedback, which allows the processor to improve the noise cancellation by adjusting its signals to the rare earth permanent magnet speaker.

One of the first ANC products on the market is a headset which is placed on a patient to be given an MRI (magnetic resonance imaging) scan, because of the loud din produced by

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these machines. The noise is reduced by about 25dB by the ANC headset, which sells for about $25,000. One can envision ANC headsets for use by construction workers, helicopter pilots and in automobiles. Even though, for example, the road noise is cut down to a bare whisper, other sounds such as honks of a horn, sirens, and conversations will be unaffected, since they are not programmed to be silenced. The next major development will be electronic mufflers for automobiles. Several 1993 luxury automobiles are expected to be equipped with ANC mufflers. This is a real plus for the automobile manufacturers because the electronic mufflers, unlike conventional ones, do not generate a back pressure, and thus in addition to noise suppression the power and performance is improved cutting down fuel consumption by 2 to 5%.

Along this line one could use the same principle to dampen vibrations, which would cut down on the wear and tear of equipment and machinery and thus extend their lifetimes. If this should develop, terfenol will probably play a role along with piezoceramic actuators. Terfenol is a magnetostrictive material made up of two rare earth metals and iron, and it has the approximate chemical formula $Tb_{0.3}Dy_{0.7}Fe_2$.

Flouride Glass Moving into Production

Last month in our feature story we told you about some of the new exciting developments that were occuring in the science and technology of rare earth-heavy metal fluoride glasses and its future promise of being one of the rare earth growth areas of the 1990's. This month we are pleased to inform you that the future is here with the announcement by Galileo Electro-Optics Corporation of Sturbridge, Massachusetts that it had completed the construction of a state-of-the-art facility for manufacturing heavy metal fluoride glass optical fibers. The Galileo plant produced these infrared transparent fibers under a license from British Telecom Research Laboratories. The fibers exhibit attenuation of less than 20dB/km at a wavelength of 2.5μm, and less than 100dB/km between 0.5 mm to 3.6μm.

Er_3Ni Cryocooler

Toshiba Corporation began shipment of Er_3Ni alloy as a cryocooler refrigerator material early this year. The Er_3Ni is expected to replace lead which is currently used as the active cryocooler material. Toshiba claimed it has used Er_3Ni to attain 2.5 K while the best units using lead has only been able to reach 10 K. The new alloy has a uniform grain size and a smooth surface, which greatly enhances the heat exchange with the helium gas used in the refrigerator. Toshiba reports that the Er_3Ni alloy withstands repeated compression and expansion cycles of the helium gas. A rapid growth is expected for these small size cryocoolers which can be used, for example, to cool superconducting magnets which are used for research and more importantly in magnetic resonance imaging (MRI) units.

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