



# Rare-earth Information Center **INSIGHT**

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## Rare Earth Silence becomes an Option

In the November 1, 1991 issue of **RIC Insight** (4, [11]) we described the use of rare earth permanent magnets to reduce noise and loud everyday sounds by active noise control (ANC). ANC cancels out sound by generating sound waves (using rare earth permanent magnet speakers) which are equal in amplitude and frequency, but completely out of phase with the noise. Nissan Motor Corp. is offering ANC as an option in its Bluebird model in Japan. According to Nissan this is the first time this technology has been used in a mass-produced car. In the Nissan ANC system, a sensor detects the firing of the engine cylinders and tells a computer to generate an "anti-noise" sound through two speakers under the front seats. This technology is expected to reduce noise levels by 88%, or 10 decibels. A version of the Bluebird, called Altima, is scheduled to be introduced in the United States this fall, replacing the Stanza.

## Rosy Future Predicted for Bonded Magnets

The outlook for bonded magnets, both ferrite and rare earth, according to several speakers at the 1992 Polymer Bonded Magnets Conference in Rosemont, Illinois (May 20-21, 1992) over the next ten years is super fantastic, especially for the neodymium-iron (NdFeB) based materials. The world-wide (Japan-United States-West Europe) growth of NdFeB bonded magnets since 1987 has just about doubled each year from 20 tons in 1987 to 500 tons in 1991. Although it cannot maintain this 120+% growth rate much longer, the annual average growth rate is predicted to vary from a low of 20% to a high of 35% over the next ten years. The value for the NdFeB bonded market in the year 2002 is estimated to be \$0.8 to 1.0 billion world-wide.

There are a lot of factors which may have a big impact on these predictions, one of them being the presidential race in the United States. The two presidential candidates, Bill Clinton and George Bush (assuming he will be the Republican Party nominee) have widely different views on the fuel efficiency of cars sold in America. The present corporate average fuel economy (CAFE) is 27.5 miles per gallon (mpg), and it is expected that this would not increase significantly if President Bush were to be re-elected. Bill Clinton has announced that he is in favor of increasing it to 45 mpg over about a ten year period. If the CAFE were increased to this level this would require a tremendous effort by automobile manufacturers to meet these goals, which would in part include reducing the weight of motor vehicles. Some of this weight reduction will be done by making the motors used in automobiles lighter and smaller, which in turn would require using bonded anisotropic NdFeB magnets.

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Other potential new markets is the use of bonded NdFeB magnets in brushless dc appliance motors for refrigerators, air conditioners, driers, washers, vacuum cleaners, etc. The brushless motor has several advantages including continuous speed control without using pulleys and belts, quieter operation and improved energy efficiency.

Several other developments were mentioned which may have an impact on the market - not necessarily new growth, but competition from new players. Mitsubishi Materials Corp. and Asahi Kasai have each announced new processes for manufacturing bonded anisotropic magnets. The Mitsubishi Materials Corp. process, which produces anisotropic NdFeB magnets, became operational last month. The Asahi Kasai new nitromagnet material ( $\text{Sm}_2\text{Fe}_{17}\text{N}_x$ ) is expected to be commercially available in 1995. The patent situation for these two developments is not clear at this time.

The Mitsubishi Materials Corp. process is called HDDR, which stands for hydrogenation, decomposition, desorption, and reaction. In the HDDR process the starting NdFeB material is initially hydrided (H) at low temperatures and during the heating to above  $650^\circ\text{C}$  it absorbs more hydrogen and decomposes (D) to form  $\text{NdH}_2 + \alpha\text{Fe} + \text{Fe}_2\text{B}$ . Then this mixture is dehydrogenated (D) below  $1000^\circ\text{C}$  by pumping off the hydrogen to reduce  $\text{NdH}_2$  to neodymium metal, which then reacts (R) with  $\alpha\text{Fe}$  and  $\text{Fe}_2\text{B}$  to form the anisotropic NdFeB powder. The trick is to keep the temperature below  $1000^\circ\text{C}$  in the last step, otherwise the powder will be isotropic.

In the Asahi Kasai process,  $\text{Sm}_2\text{Fe}_{17}$  is reacted with a  $\text{NH}_3\text{-H}_2$  gas mixture to form  $\text{Sm}_2\text{Fe}_{17}\text{N}_x$ . The best magnetic properties are obtained when  $x = 3$ : a Curie temperature of  $490 \pm 10^\circ\text{C}$ , a  $\text{BH}_{\text{max}}$  of 20 MGOe, a saturation magnetization of 15.6 kG and an anisotropic field of 230 kOe. Nitromagnet will only be used as a bonded magnet because  $\text{Sm}_2\text{Fe}_{17}\text{N}_x$  decomposes at  $600^\circ\text{C}$ .

The SmCo bonded permanent magnet market is expected to continue its 3 to 5% annual growth rate over the next ten years. These magnets will have their special niche where high Curie temperatures and chemical stability are critical. The major problem is the cobalt availability, but with the end of communism in the former USSR, cobalt may be available on a regular, steady basis at a reasonable price without large price fluctuations from Russia, which has large reserves.

### Automotive Glass - the Next Big Market?

Will your next automobile contain  $\text{CeO}_2$  in its windshield and other windows? It is a distinct possibility according to some sources, but others are not as optimistic. The  $\text{CeO}_2$  would be added to the glass to absorb ultraviolet radiation, a standard practice in the bottling industry. The rationale is that by absorbing the non-visible light by  $\text{CeO}_2$  the solar heating would be less and thus the air conditioning unit could be smaller resulting in weight savings, helping to increase the gas mileage. Another plus is that less CFC's (chlorofluorocarbons) or their replacements are needed in the air conditioning unit. If this potential use should be realized it would give the rare earth industry a big boost, even if only the USA automotive industry adapted this technology.

  
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