Beryllium: The Magic Metal for Tweeters
September, 2007

John E Johnson, Jr.

You probably have seen recent information from various speaker manufacturers that they are starting to use pure beryllium as the material to make tweeter domes from. Do you know why this is such an important advancement in tweeter design? Read on.

Thinking back to when you took chemistry in high school or at the university, you remember the Periodic Table of the Elements. I took college chemistry in 1964, so the table has increased a bit since then. But the basic elements have remained the same since their discovery over hundreds of years.

There are a couple of numbers that are important in our discussion here. One is the Atomic Number, and the other is the Atomic Mass (also called Atomic Weight).

Tweeters have been made of several materials over the years. At first, they were small cones, made of paper just like midrange drivers and woofers. Then manufacturers started making "domes" of different things, including doped silk. The whole idea was to keep the tweeter as light as possible, because the lighter it was, the more detailed the sound. This is directly proportional to the mass of the driver. If the driver is very light, it can move back and forth quickly, with less problems due to inertia. Besides silk - which is strong and light when it is thinly coated with polymer - aluminum domes came into being. Aluminum is low on the atomic mass chart: 26.98. It sits as Atomic Number 13. Hydrogen (H) is number 1, followed by Helium (He) at number 2, Lithium (Li) at number 3, and...whoa...Beryllium (Be) at number 4. That's right, beryllium is only 3 up from the lightest element hydrogen on the scale. Its Atomic Mass is 9.01, so in other words, if you make a tweeter dome out of beryllium at the same thickness as an aluminum dome, it is going to be three times lighter in weight. And, that means, you guessed it, better sound quality, i.e., less harmonic distortion because there is less inertia.

The problem with beryllium is that (1) it is very brittle so it is hard to work with, and (2) it is toxic, so again, it is hard to work with. It is also a much more expensive material to purchase, but that is not really an issue because so little of it is used in the tweeter dome. Manufacturers of beryllium tweeters cover the dome with protective grilles, so that you can't touch it. The dome is thin and strong, but it is also delicate.

Many years ago, I worked with X-ray detectors in electron microscopes. These were small tubes that were connected to an evacuated column, and which collected X-rays emitted by materials that were bombarded with an electron beam. Each element in the material being studied would give off X-rays

that were characteristic of those elements, so an analyzer connected to the detector could plot a graph of the elements in that material, such as iron, zinc, aluminum, etc.

In order to separate the detector from the vacuum, a small window was mounted on its opening. That window had to be covered by a membrane made of something very low in atomic mass so that would not impede the X-rays. It was decided to make it of beryllium. The beryllium membrane was very, very thin, on the order of microns. So, you can see that beryllium is not only very low on the Atomic Mass scale, but it is very strong. It is a metal.
As a result, beryllium tweeter domes can be made much thinner than their aluminum counterpart, and this results in a dome that is incredibly light, much lighter than any aluminum dome could ever be. So, thinner + lower atomic mass = less distortion.

The "Velocity of Sound" is something that can be calculated for various metals. This number for beryllium happens to be 13,000 meters per second, and that is about twice that of other metals such as aluminum and magnesium. It is also less prone to Destructive Resonance, which occurs with random excitation, and therefore, a good damping material (it does not "ring" like aluminum does). In fact, its internal damping characteristics are very much like silk dome tweeters, which tend to sound very smooth.

The Modulus of Elasticity (tendency to lengthen when subjected to stress) for beryllium is about 30% higher than steel, which indicates it is less likely to deform when it is subjected to acceleration (changing directions when it is going back and forth to produce sound). Again, this means less distortion.

It's also non-magnetic, which of course, is an absolute must-have for a speaker dome material.
Now, the use of beryllium in tweeters is not entirely new. It actually dates back to the early 1980s. However, until the last couple of years, beryllium was only used as a coating on another metal. Pure beryllium tweeter domes are a recent advance in the technology, and pure beryllium as a material to work with is only manufactured in the US, France, and Russia. Other countries manufacture it as an alloy.

So, are you excited? You should be. A new age of high frequency performance is upon us. Since tweeters can go down to 1.5 kHz or so, that is a huge part of the audible spectrum.

You are about to enter a new world of audio performance, thanks to a metal you have probably never seen before: beryllium.