

Boston Audio Design™



The Mat 1™: A White Paper

The following article outlines some of our thoughts on analog playback, why we use pure carbon-graphite for the Mat 1, and how this all relates to your enjoyment of music.

So why bother designing a new turntable mat? We believe that much of what makes a good turntable great can be accomplished by optimizing the platter/vinyl interface – the last component in the record support system and the only part of the turntable capable of dealing with stylus-induced oscillation.

While there are already many good turntables on the market, most manufacturers, especially when designing tables priced under \$3,500 or so, are forced to make serious compromises regarding the platter/vinyl interface. Why? The economics of producing a profitable product at a low price demand compromise in both labor time and material choices. In other words, if a manufacturer designs a truly great mat for a \$1,000 turntable, he can no longer afford to sell it for \$1,000.

Thus we introduced the Mat 1 to address perhaps the most common shortfall of the turntables many audiophiles already own.

Stylus Oscillation

The purpose of a stylus assembly is to generate mechanical impulses that are ultimately translated by your stereo into music. But we all know that for every action there's an equal yet opposite reaction - so as the stylus oscillates while reading the millions of bumps and ridges within the groove, it consequently releases a portion of that vibration back into the vinyl itself (the opposite reaction).

These vibrations saturate the vinyl and bounce off the platter and back to the stylus, creating a feedback loop that smears new information with the reflection or echo of a moment earlier - a seemingly inevitable degradation of information that robs music of detail, clarity and immediacy.

Even in the most rigorously setup and isolated turntables, stylus oscillation is a source of distortion that is hard to avoid.

Popular Approaches to Mat Design

Contemporary turntable manufacturers are well aware of this issue and have used a variety of materials to combat it - typically felt. Some manufacturers even make their platters out of "dead" materials like acrylic compounds in an attempt to absorb resonances, but the result - as often as not - can make the music sound dead and dull as well.

Two popular approaches to controlling stylus resonance have been to 1) dampen resonance by making turntable mats from felt or foam and 2) decouple the record from the platter in an attempt to provide a better path through which vibration may be released into the air.

Felt mats do dampen some of the vibrations generated by the stylus and help to insulate the record from the platter because of its low mass. But precisely because of felt's extremely low mass, its effectiveness is limited. Felt isn't an ideal solution, but at least it has a reasonably accurate frequency response that doesn't get blatantly in the way of the music which is one of the reasons felt mats are ubiquitous today (in addition to the fact they cost only pennies to produce). But there are many better options.

Decoupling products such as the Ringmat and the Rosenkranz Lotus (not available in the USA) suspend the record above the platter using cork rings or small copper pucks, respectively. The decoupling method has an effect because it separates the record from the platter and reduces one source of resonance - stylus vibrations reflecting off of the platter. But just as there is little preventing vibrations from being released while suspended, there is, unfortunately, nothing prohibiting vibrations from entering from the air or simply oscillating within the vinyl.

While sometimes an improvement over felt mats, decoupling the record from the platter also alters the frequency balance by changing the resonant modes of the record. You can easily experiment with this phenomenon with your record player by putting a triangle of coins about 2 inches out from the spindle and suspending the record on top of that. More detail? Has the signal-to-noise ratio been magically improved? Or is the midrange just a bit elevated?

Try some no-slip or cork shelf liner or even use another record as a mat while you're at it. Some mat materials seem to impart more "detail" by boosting the midrange or treble and others give a "lush" sound by sucking out midrange energy, leaving the impression that bass and treble have been accentuated.

But at the end of the day, making truly a better mat – a mat that reduces the effects of stylus oscillation without becoming an unpredictable tone control - is a tricky proposition.

Rediscovering Carbon-Graphite

During the search for the ideal mat, we auditioned every conceivable material and configuration imaginable. It gradually became clear that finding the right material was more of an art than a science. In other words, just as results observed from decoupling the record from platter vibrations were less than ideal, so too were results observed from dampening vibration to the extreme. For example, our work with carbon fiber clearly over-damped the record and resulted in a bland, lifeless sound. Each record mat approach offered pros and cons - but nothing that, in our opinion, seemed to bring us closer to the live event.

Our search ultimately led us to a rather exotic material for a turntable mat - pure carbon in the form of graphite. Commonly used in industrial applications including nuclear power plants and steel mills because of its high thermal conductivity, graphite is made from carbon atoms arranged in a hexagonal, honeycomb pattern that are tightly bound in ultra-thin sheets. These sheets are themselves very loosely bound to one another - which is why powdered graphite is one of the best industrial lubricants in existence – and one of the reasons graphite is so effective at absorbing energy.

Graphite also offers one of the lowest mechanical impedances of any material in existence. Simply put, mechanical impedance is a material's resistance to energy. Graphite's low mechanical impedance means that energy may freely enter the material, but its loosely bound molecular layers are very efficient in absorbing and dissipating energy - be it neutrons generated by a nuclear reaction or micro-vibrations from a stylus.

In addition to absorbing and dissipating stylus oscillation, graphite is excellent at absorbing turntable-produced contamination including bearing and pulley imperfections, motor noise, platter ring and even noise generated by the belt turning the platter. But that's a subject for another paper...

It's also important to understand that true carbon-graphite is *not* "graphite" as in carbon fiber golf clubs, tennis racquets, etc. While such products are often mistakenly called graphite, carbon fiber is a composite material with totally different mechanical properties than pure carbon-graphite.

Designing and Manufacturing the Mat 1

There are dozens of grades of graphite, each with different physical properties. In designing the Mat 1, we painstakingly chose the very best grade of graphite for use with vinyl based on listening tests and impedance matching. Since the Mat 1 and vinyl have complimentary mechanical impedances, vibration from the vinyl may easily pass into the mat, where it is promptly dissipated.

In addition, we also paid exhaustive attention to the physical dimensions of the mat - from its thickness and diameter to the precise dimensions of the recessed record label cutout - to most efficiently counteract stylus oscillation and isolate the stylus from turntable-generated noise.

But finding the right grade of carbon and optimizing the mat's physical design is only half of the story - the mat must also be finished and sealed to prevent graphite residue from rubbing off on your hands and records. In fact, another use of graphite (when mixed with clay) is as pencil "lead" if that gives you any idea of what an unfinished mat is like! Appropriately sealing the mat proved to be one of the most daunting tasks in finalizing the Mat 1 since most sealants interfere with the mechanical properties of the mat, greatly reducing the many benefits enjoyed when using the "nude" mats.

We took a two-pronged approach to this problem. First, it is possible to remove 90% of loose graphite particles by polishing the mats at high speed. So after being CNC machined, each side of the Mat 1 is polished at speeds of over 4,000RPM. Second, our proprietary sealant is applied with an automotive-quality HVLP spray system to ensure precise and even coverage. The benefit of our sealant is that it is incredibly thin (only a few microns) so that it doesn't degrade the natural acoustic properties of the mat. In fact, the slight dampening produced by using our sealant yields a sound quality consistently preferred by our listening panel in blind tests when compared with nude mats. Each Mat 1 receives four coats of sealant.

Wrapping Up

We hope you found this article helpful in understanding some of the issues involved with designing an effective turntable mat and how we arrived at the Mat 1. Two years were devoted to developing and releasing the Mat 1, and we hope analog perfectionists will think the wait was worth it. We believe the improvements in detail and clarity afforded by using the Mat 1 bring you significantly closer to the musical event, making it one of the most cost effective upgrades you can make to your turntable.

We welcome any thoughts or feedback you have about this article. Please email them to me at austin@boston-audio.com.

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your dealer or visit www.boston-audio.com.**