Selection and use of shielded aluminum honeycomb air vent filters

Aluminum honeycomb panels are an option for the manufacture of low-cost shielded air vent filters when shielding and high air volume are of concern.

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Honeycomb material (which is approximately 96 percent open) is frequently selected for manufacturing air vent filters due to the low wind resistance to the air flow that is required for cooling modern electronic equipment. Aluminum is frequently selected for its low cost. The shielding of a 1/8-inch cell, 1/4-inch thick panel varies significantly (from as little as 12 dB to as much as 70 dB over the frequency range of 100 kHz to 1 GHz). This article examines the cause of the significant variations in the shielding and provides information on an innovative new process used to provide reliable high levels of shielding at competitive prices.

DEVELOPMENT OF HONEYCOMB SHIELDED AIR VENT FILTERS

It is well known that honeycomb panels can be used to provide shielding to electromagnetic fields while allowing air to penetrate enclosures for cooling purposes. The first honeycomb panels were made from copper, brass or iron foils and soldered, welded or brazed together to form an array of adjoining honeycomb cells. Due to cost considerations, aluminum honeycomb panels, where the foils are epoxyed together at their abutting segments, were tested for their shielding quality.

Aluminum panels with the abutting segments epoxyed together became the low-cost material of choice when a reduced level of shielding was acceptable. The industry originally applied pin holes through the abutting segments to insure that a conductive path existed between the aluminum foils at the segments. It soon became apparent that the cutting (sawing) of the honeycomb into panels supplied as much conductivity between the foils through incidental contact at the abutting segments as the pin holes, and the practice of supplying pin holes was abandoned.

Many customers of the aluminum air vent filters wanted corrosion and/or corrosion-compatible filter assemblies. Compliance with the corrosion requirements resulted in plating the filter assemblies. The plating primarily used is tin and chemical film. Tin was preferred, as it was discovered that the tin plating could result in improved shielding. It has also been discovered that such plating processes can significantly reduce the level of shielding. This reduced level is caused by the removal of the incidental contact points during the pre-plating caustic etch process. Figure 1 illustrates the level of shielding of three aluminum panel materials which

*See advertisement on page 2

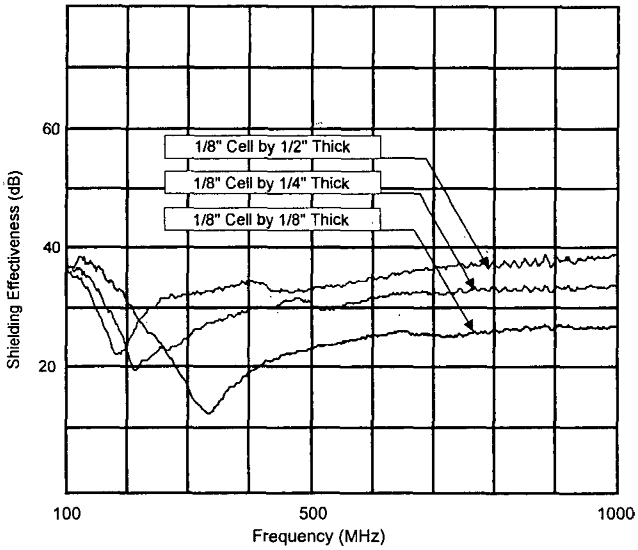


Figure 1. Shielding effectiveness of honeycomb panels after being subjected to a caustic etch.

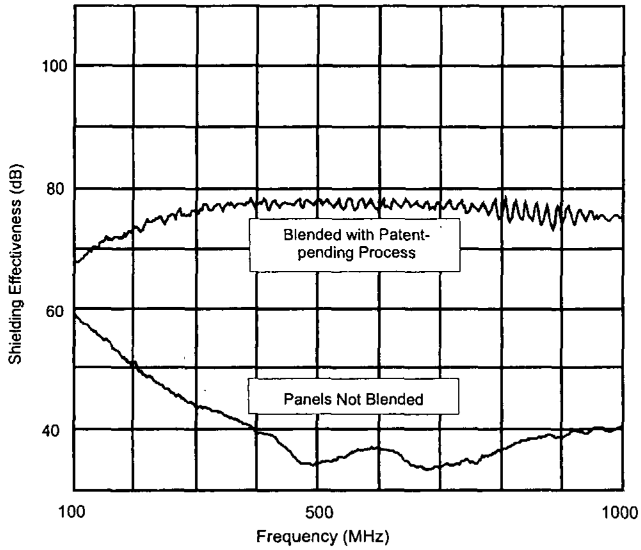


Figure 2. Shielding effectiveness test data of honeycomb panel, 1/8-inch cell by 1/4-inch thick.

were subjected to an extended pre-plating caustic etch. As can be seen, the shielding of the panels is extremely poor.

DEVELOPMENT OF HIGH RELIABILITY FILTERS

SHIELDING

The conductivity across the foils normally supplied by aluminum honeycomb filter materials is the result of incidental contact between adjacent aluminum foil segments at the abutment area due to the sawing operation used to cut the panels. As such, the level of shielding offered by aluminum honeycomb panel materials can vary significantly. The caustic etch used in plating processes can be instrumental in reducing the level of conductivity by removing some of the incidental contact points.

One patent-pending process on aluminum honeycomb panels blends one of the aluminum foils at the abutting segments across the epoxy barrier onto the adjacent foil. This results in a consistent reliable level of shielding. Figures 2 and 3 illustrate the difference in the shielding effectiveness between honeycomb panels which have been subjected to the blending process and panels which have not been blended. Figure 2 illustrates the difference using a single 1/8-inch cell by 1/4-inch thick honeycomb panel. Figure 3 illustrates the difference when two adjacent (double) honeycomb panels were tested. In both cases, the panels which were blended and not blended were from the same purchased lot.

RELIABILITY AND COST

The recommended material for the frame of the filters is 6061 aluminum. This material is slightly more expensive than the more popular 6063 material. However, its corrosion resistant properties provide reliable long life without additional plating.

Tin plating of the frame is used on dual cell filters as it is required to obtain the higher levels of shielding offered in this series. Tin and chemical film plating are also offered when compatibility concerns so dictate. The plating of the components which are used in the manufacture of the filters is accomplished prior to the assembly of the filters. This guarantees that the acids and other chemicals used in the plating process are totally removed from the filter members. This insures a long reliable life of the filters.

EMI gasket materials are used to obtain an excellent,

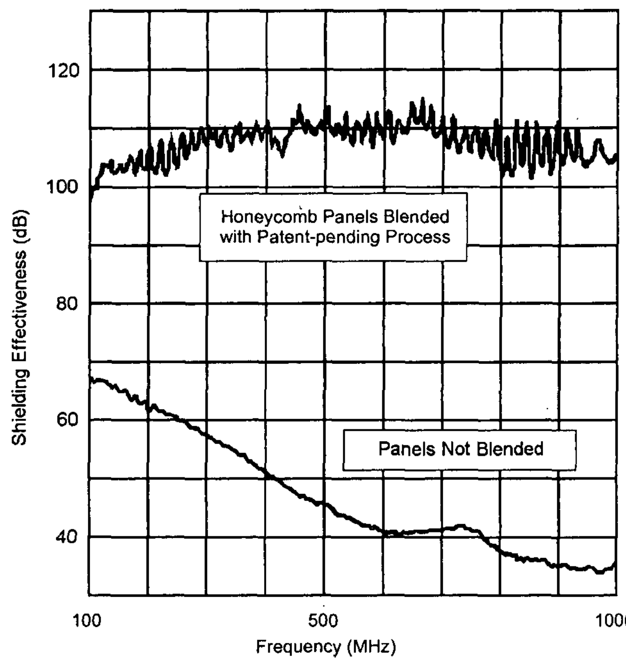


Figure 3. Shielding effectiveness test data of double panel air vent honeycomb filters, 1/8-inch cell by 1/8-inch thick.

reliable frame-to-chassis bond on the filters. The gaskets are also employed for the honeycomb panel-to-frame electromagnetic bond on some filters. The spiral gaskets are employed for the purpose of absorbing thermal expansion and contraction, shock, and vibration to insure an excellent electromagnetic bond throughout the life of the filter.

A fully-automated machine has been developed and is used to cut the frame to size. This machine is coupled with several automated and semi-automated processes used to apply epoxy to the frame/honeycomb panel interface for mechanical strength of the filter, and to install the electromagnetic (EM) bonding spiral gasket to the extrusion. These machines and processes significantly reduce the time required to manufacture and assemble the filters.

LOW COST FILTERS

Among the many filters available are two types (series) of low cost, shielded aluminum, honeycomb air vent filters. Both series utilize the patent pending "blending" process on the honeycomb panels which provides a reliable level of shielding. The shielding offered varies from 60 dB to over 125 dB at 1 GHz, where the level of shielding varies as a function of the variables used in the manufacture of the filters.

One type is designed to meet relatively low-level EMI requirements at a very low cost. It features a knife-edge extrusion to achieve the honeycomb panel-to-frame EM bond. This design is recommended for applications where a low to moderate level of shielding is required, low cost is essential and long life is not anticipated. The other filter components consist of an aluminum frame honeycomb processed with our patent-pending process and stainless steel gasket for the frame-to-chassis electromagnetic bond. The filter is for use in a relatively low humidity environment.

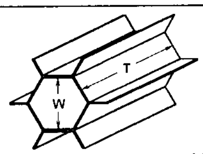
The second type is a high reliability air vent filter supplying moderate to high levels of shielding. The filter uses aluminum honeycomb material specially processed for high, reliable shielding and comes in both single and double panel configurations. The single panel configuration uses a 6061-T4 aluminum frame and tin-plated stainless steel gasket for the electromagnetic bonding between the panel and frame and frame-to-chassis. The double panel configuration uses a tin-plated 6061-T4 aluminum frame and tin-plated stainless steel gaskets for the electromagnetic bonding. Versions are available for high humidity and salt fog environments (through selective plating of the frame honeycomb panel and gasket).

The configurations are illustrated in Table 1. Figures 4 through 7 illustrate the frame and EM bonding configurations and the level of shielding offered by the filters.

CONCLUSION

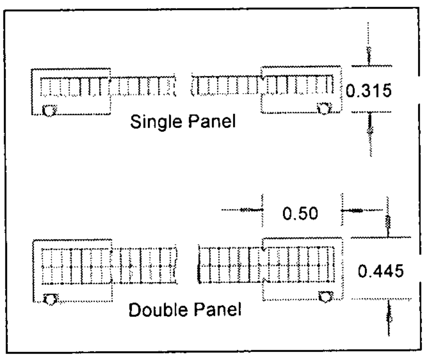
Honeycomb air vent filters are used extensively in the electrical/electronic industry to shield electromagnetic fields when a high volume of air is required.

Aluminum foil where the abutting segments are epoxyed together is the low cost material of choice when the

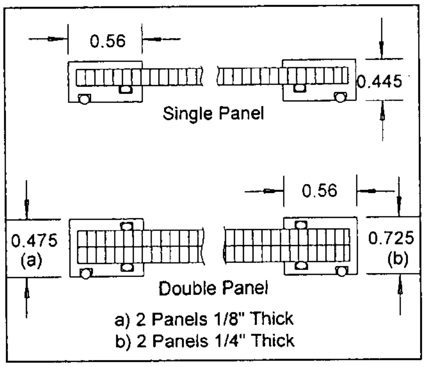


Filter Type	Number of Panels	Cell Size Width (W)	Cell Size Thickness (T)
Low-level Shielding	1	1/8"	1/8"
	2	1/8"	1/8"
High Reliability Filter	1	1/8"	1/4"
	2	1/8"	1/8"
	2	1/8"	1/4"

Table 1. Air vent filter configurations.



Figures 4. Filter configurations for low-level EMI requirements.



Figures 5. Filter configurations for moderate to high levels of shielding.

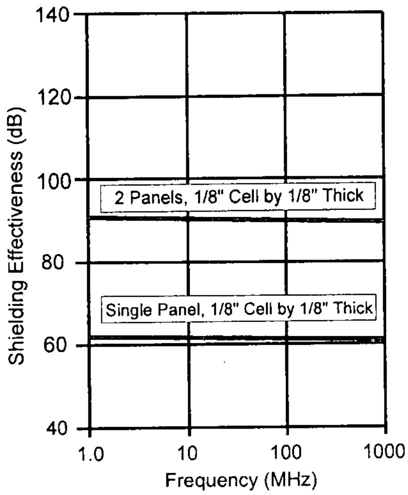
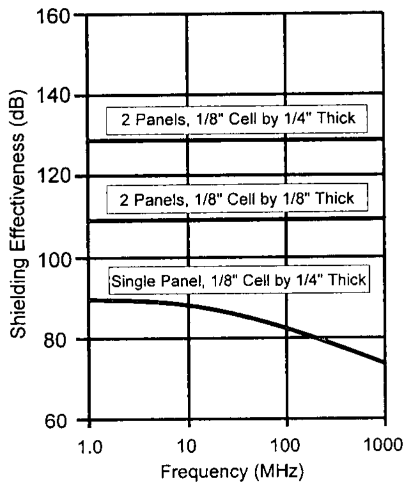


Figure 6. Shielding effectiveness of low-level filters.



Figures 7. Shielding effectiveness of high reliability filters.

high levels of shielding associated with the soldered or welded honeycomb panels is not required. However, it is well known throughout the industry that the levels of shielding associated with the use of aluminum honeycomb panels can vary significantly. This means that when a specific reliable level of shielding is required, the soldered or welded honeycomb panel material is usually specified.

A patent pending blending process adds a consistent level of reliability to the honeycomb panels manufactured from aluminum foil. The use of two panels sandwiched together offers both the reliability as well as the level of shielding generally associated with the soldered and welded honeycomb panels.

The automated and semi-automated machines and processes used to manufacture the shielded honeycomb air vent filters result in a very competitive cost advantage. This is particularly true regarding the double panel.

GEORGE KUNKEL received his Bachelor of Science (B.S.) and Master of Science (M.S.) degrees in engineering from the University of California at Los Angeles (UCLA). As a graduate student, he was a member of the teaching staff, and subsequent to graduation, taught courses on applied electromagnetic theory in the UCLA extension department. He is presently a member of the Deans Council, College of Engineering at UCLA. Mr. Kunkel has worked as an engineer in electromagnetic effects (EMI, TEMPEST, EMP, lightning and RADHAZ) design for 30 years, the last 20 of which have been as a consultant. He owns the U.S. patent on the Spira EMI gasket, has been responsible for the design and manufacture of the gasket and is President of Spira Manufacturing Corporation.

A Senior Member of the IEEE, George was Chairman of the Technical Committee on Interference Control for the EMC Society of the IEEE from 1969 through 1987. He has published numerous papers on grounding, bonding, shielding and filtering and has chaired symposium sessions on these topics at IEEE EMC Society International Symposia. (818) 764-8222.