



# EMI/RFI Composite Shielding: Reducing Electromagnetic Interference in Composites

Electronic components give off electromagnetic energy which can cause interference to the function of other electronic devices, and this must be minimized. Contrary to what many believe, composites can be excellent EMI attenuators. NASA uses EMI shielded composite materials for space exploration. The Air Force uses EMI shielded composites extensively, as is evidenced by the stealth fighter and bomber. Law enforcement agencies use thermoplastic EMI shielded enclosures in much of their communications equipment, including a shielded auto console which houses two way radios and other electronics.

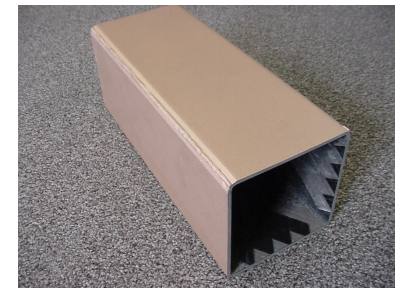
EMI and RFI are defined as follows:

- EMI - Electromagnetic Interference
  - A general range of freq. 0 Hertz to  $1 \times 10^{24}$  Hertz
  - Radio, infrared, light, UV, X-ray, gamma, cosmic
  - Man-made devices operate at 10 kHz to 10 GHz
- RFI - Radio Frequency Interference
  - A Specific range of freq. 3 kHz to 300,000 Mhz
  - VLF, LF, MF, HF, VHF, UHF, SHF, EHF

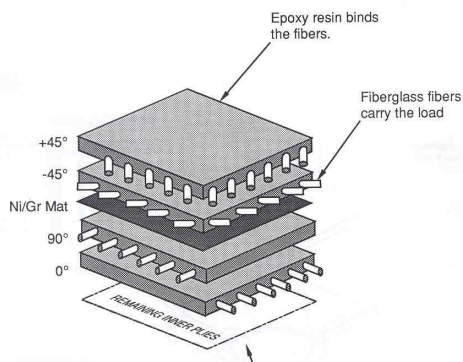
**Figure 1  
Ni/Gr Mat**



**Figure 2  
Copper Coated**



**Figure 3  
Shielding Lamination**



Materials used in the shielding of composites can vary. Typical materials include carbon fiber, nickel coated carbon fiber mat (Ni/Gr) (Fig. 1), Nickel-steel alloy sheet, copper wire mesh and various varieties of metallic paints (Fig. 2), coatings and conductive fillers. Shielding effectiveness of Ni/Gr mat is shown in Table 1.

Integration of shielding material into a composite laminate is best accomplished by embedding the material into the actual laminate, producing a durable attenuating layer (Fig. 3).

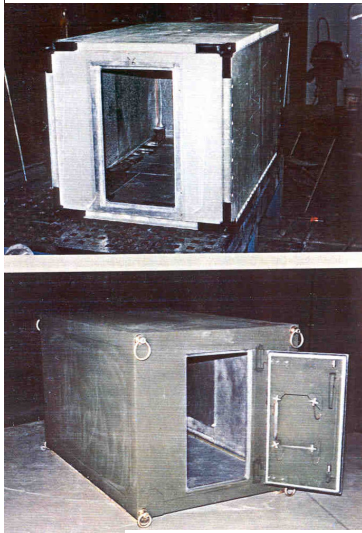
A key to the success of shielding with composites is to maintain conductivity between the various components in a structure. Joints need to be specifically addressed, as this is a “leak” point for any shielding structure. Low

**Table 1: Ni/Gr Mat Shielding Effectiveness**

Grade #	Weight oz/yd <sup>2</sup>	Caliper mils	Surface DC W/δ	Shielding Effectiveness (in dB Attenuation)							
				10 MHz	100 MHz	200 MHz	400 MHz	800 MHz	1 GHz	10 GHz	17 GHz
8000854	0.20	2.2	0.93	42	44	54	45	36	28	29	30
8000855	0.33	3.4	0.65	46	47	54	51	40	36	35	37
8000842	0.50	4.4	0.36	44	40	49	44	34	36	42	40
8000877	0.60	4.5	0.21	53	49	61	56	54	38	50	55
8000823	0.75	6.2	0.73	43	45	53	49	38	34	33	35
8000843	0.75	6.0	0.27	51	50	62	55	54	47	60	55
8000844	1.00	6.9	0.26	50	53	62	55	54	49	66	55



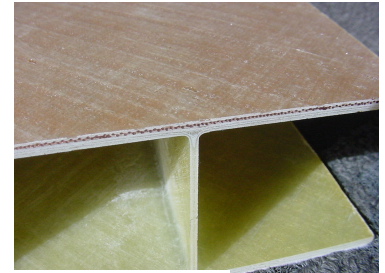
**Figure 4  
Composite Shelter**



frequency, magnetic attenuation is probably the most challenging area for composite shielding, as this frequency is best shielded by the shear mass of a conductive material, i.e. metals.

Military electronics shelters have been fabricated, tested and delivered (Fig. 4). This shelter required EMI shielding. The shelter walls were of truss core construction with a copper mesh imbedded in the laminate (Figure 5). The Copper mesh was tested against several other shielding alternatives, including nickel foil and nickel coated graphite veil (Table 2). Copper mesh showed the best all around results for the shelter application.

**Figure 5  
Copper Mesh**



**Table 2  
Shielding Test Results**

Signal Attenuation (-db)					
Construction	Level	Mag.	Electric.	Plane	Notes
.03" integral Ni/Gr* & .008" Ni foil** on surface	1	83	>90	96 min	Ni foil has excellent performance, but requires secondary application
.03" integral Ni/Gr	1	37	56-83	59-68	Too low in many frequencies
.014 Ni foil on surface	1	106	>90	90 min	Ni foil has excellent performance, but requires secondary application
2 integral layers of .003" Ni/Gr	1	33	79-80	57-64	Separation of the .003" plies improves performance
Integral 30x30 copper wire mesh	2	66	>93	14-67	Filters magnetic but not the high frequency plane due to mesh size
Same with butt joint	2	63	>93	16-72	No loss due to joint
Same with minor repair	2	64	>93	15-68	No loss due to repair
Integral Ni/Gr 60***	3	13	70-106	68-85	Good candidate, but low magnetic RFI
Integral Ni/Gr 60 on inner & outer panel skins	3	15	89-111	91-109	double layer greatly improves shielding
Integral 80x80 copper wire mesh	3	55	90-128	63-84	Better high frequency filter than 30x30 mesh. Less magnetic attenuation.
Joint with Ni/Gr 60	3	13	71-106	37-67	20-30 db leakage of plane wave RFI through the joint
1/2 scale shelter	3	3	30- >80	35-55	Large RFI leakage at joints

\* Ni/Gr = Nickel coated graphite mat

\*\* Ni Foil = Nickel alloy steel @ 0.004" foil rolls or 0.14" sheets

\*\*\* Ni/Gr 60 = Nickel coated graphite mat called SAFE-N-SHIELD 60. Similar to .030" Ni/Gr mat

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