

# PIFRAM

(Polycrystalline Iron Fibers Radar Absorbing Material)  
for RCS Management

Technical presentation



MWT Materials, Inc. 90 Dayton Ave, Suite 6E, Passaic, NJ 07055

May 2003

# Absorber Comparison

| Performance Characteristics | PIFRAM | CIP | Electrical |
|-----------------------------|--------|-----|------------|
| Low Weight                  | √      |     | √          |
| Thin                        | √      | √   |            |
| High Absorption             | √      | √   | √          |
| Multiple Loss Mechanisms    | √      |     |            |
| Absorb Traveling Waves      | √      | √   |            |



# PIFRAM Vs. CIP

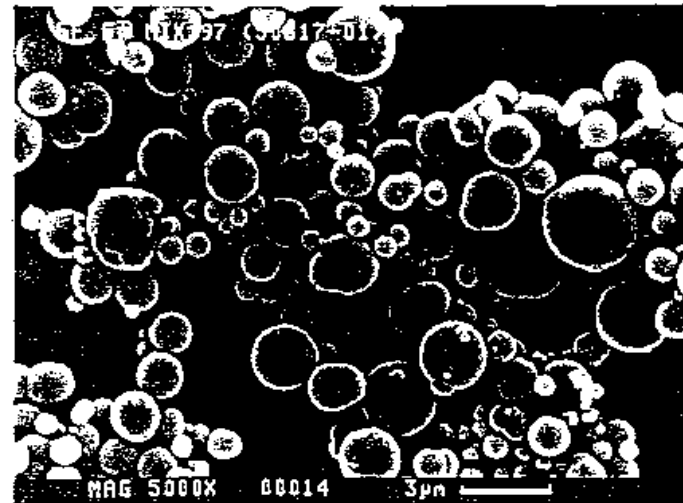
- **PIFRAM Iron Fibers**

- Low Fiber Density
- Structural Reinforcer
- Magnetic and Eddy Current Loss Mechanisms
- Isotropic or Anisotropic



- **Carbonyl Iron Powder**

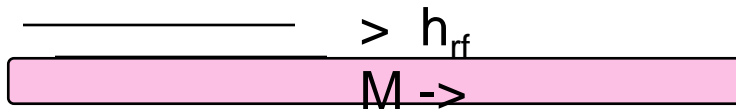
- High Particle Density
- Poor Structural Integrity
- Magnetic Loss only (No Eddy Current Mechanism)
- Isotropic Performance Only



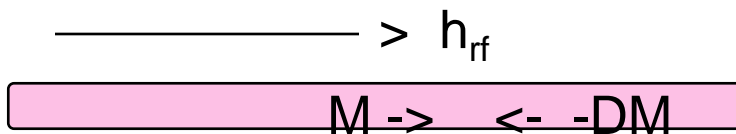
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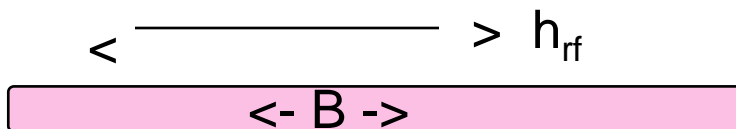
# PIFRAM Eddy Current Loss Mechanism



$h_{rf}$  Magnetizes particle

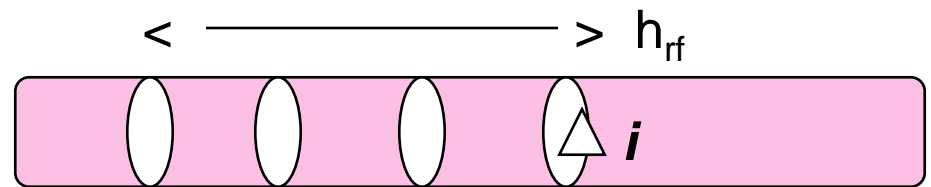


Magnetization causes demagnetizing field



Flux Density =  $h_{rf} + M(1-D)$

- Magnetic field induces EMF  
 $EMF = -dB/dt = -u^2 dH/dt$
- EMF causes current flow  
 $i = EMF/p$  ( $p$ =resistivity)
- Current causes power dissipation  
 $W = i^2 p = u^2/p (dH/dt)^2$



Oscillating B induces eddy currents which cause absorption



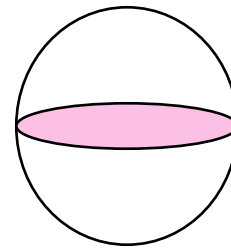
# Effective Permeability

- Effective Permeability =  $u_{\text{eff}} = (1/N * u) / (u + (1 + 1/n - 1))$

- For a Sphere,  $N=1/3$

$$u_{\text{eff}} = 3u / (u + 2)$$

$$\text{Limit of } u_{\text{eff}} = 3$$



- For a Rod

// to Axis,  $N \rightarrow 0$

$$\text{Limit of } u_{\text{eff}} = u \quad (!)$$



⊥ to Axis,  $N \rightarrow 1/2$

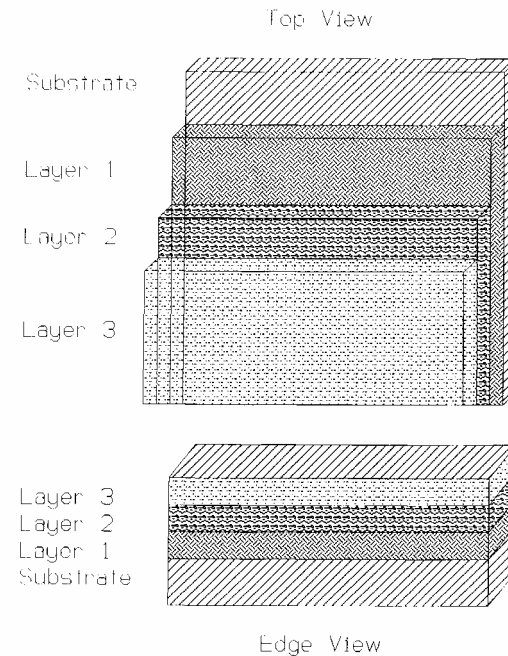
$$u_{\text{eff}} = 2u / (u + 1)$$

$$\text{Limit of } u_{\text{eff}} = 2$$



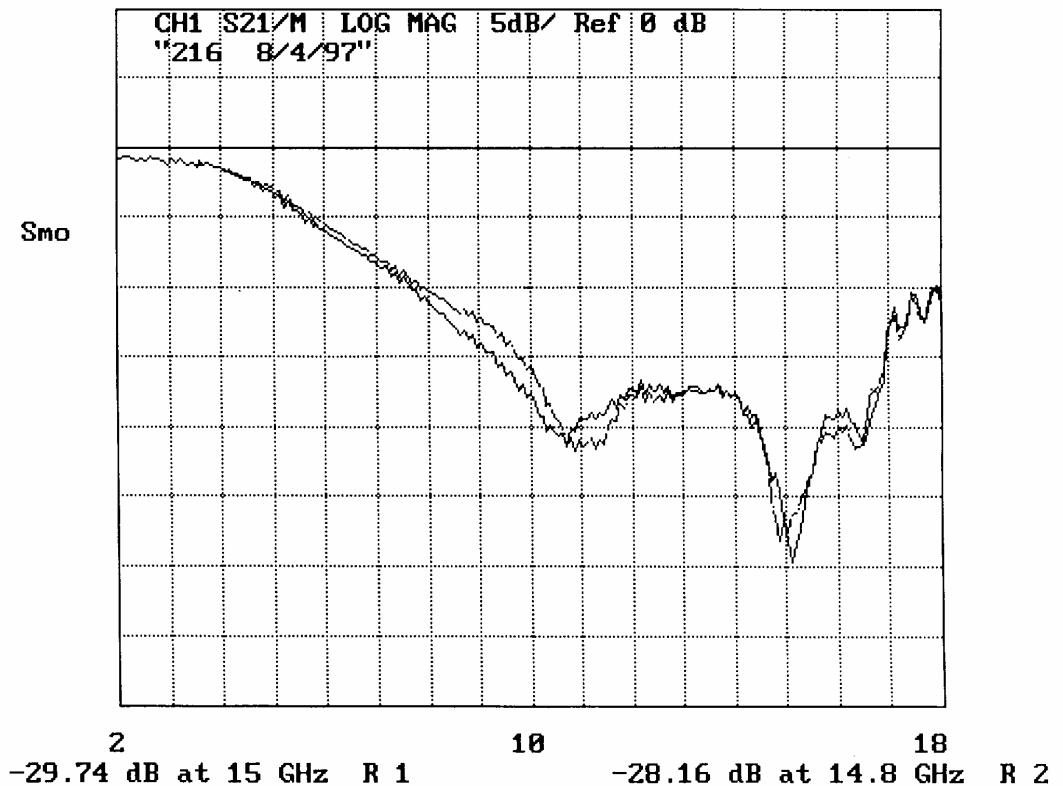
# Enhanced Wide Band Product Configuration

- Custom Configuration of thin PIFRAM Layers yields enhanced wide band performance
- Proprietary configuration of Layer 2 enables us to tailor performance with very low weight and thickness



# Enhanced Wide Band Performance

- Wide band composite system
- 2.7 kg/m<sup>2</sup>
- 2.4 mm thick
- Extremely Low weight for available bandwidth

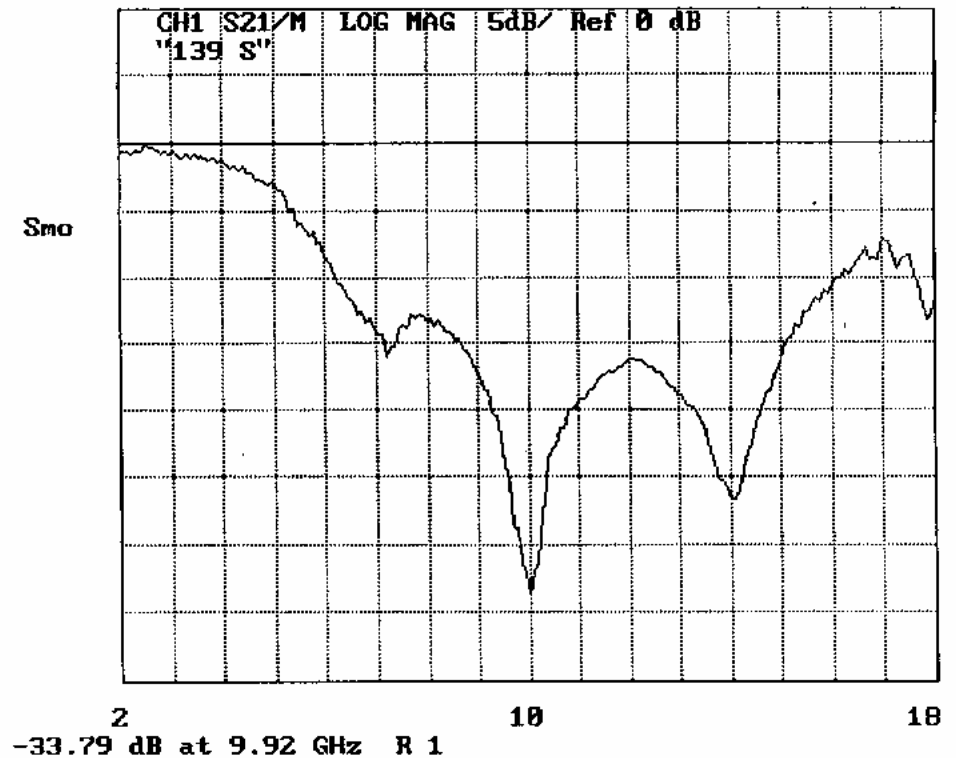


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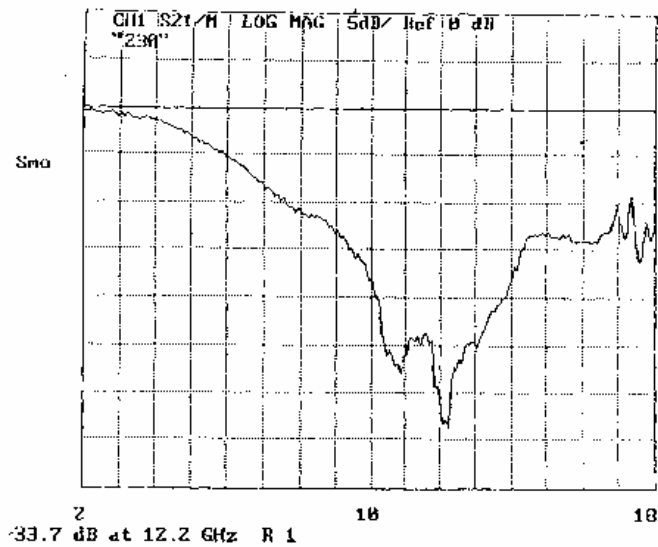
# Low Frequency Wide Band Performance

- Wide band composite system
- 2.7 kg/m<sup>2</sup>
- 2.5 mm thick
- Extremely Low weight for available bandwidth

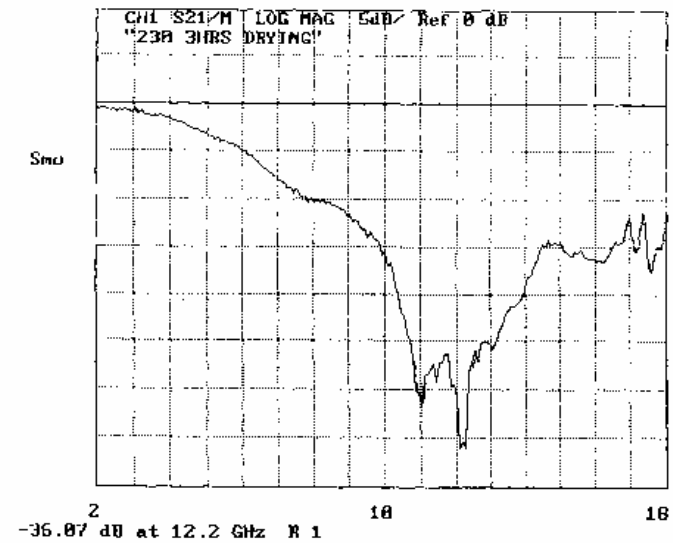


# Material is Stable in Salt Water

Prior to Salt Water Exposure



After 18 hours immersion

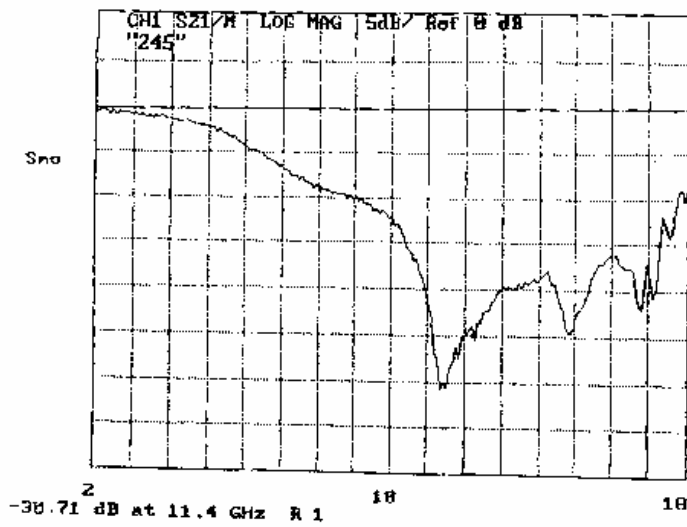


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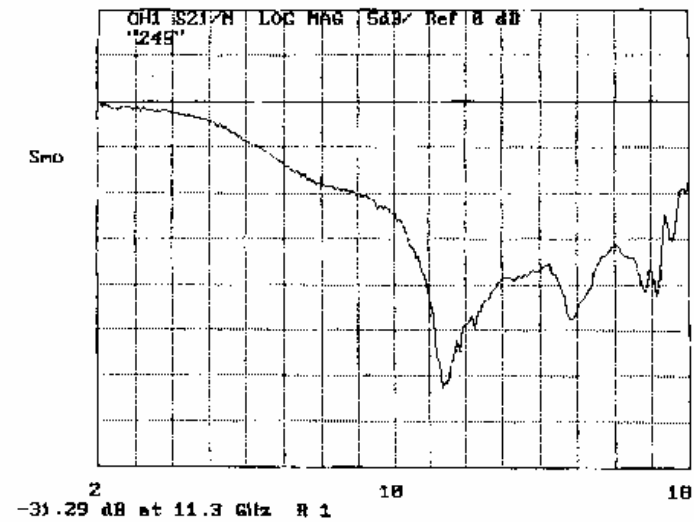
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# Material is Stable in Jet Fuel

Prior to Jet Fuel Exposure

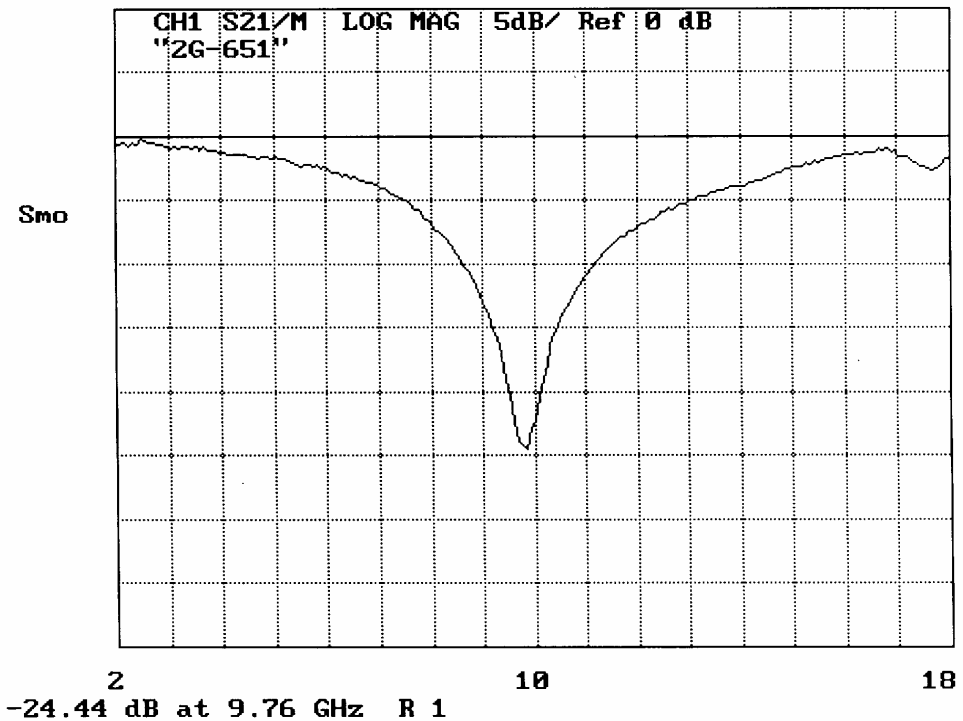


After 18 hours immersion



# Tuned Performance at Very Low Weight

- Weight of 2.05 kg/m<sup>2</sup>
- Thickness 1.25 mm
- Single Layer
- Tuned absorber for ship borne navigation radar



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# Summary



- PIFRAM, a broadband lightweight electromagnetic absorber is the solution for the retrofit market.
- PIFRAM provides Extended Life and Enhanced Survivability for Platforms already in inventory
- Robust system reduces RCS while maximizing payload and platform performance



# Millimeter Wave Technology

- Technical Questions:  
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