Invited talk at MIICS 2006

Understanding the Effects of Coating on Antennas

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1. Background

Coatings are widely used in antenna manufacturing for reasons linked to appearance, mechanical and electrical performance. There are basically two types: ***metallic and dielectric***.

- *Metallic painting/coating* is aimed at providing
  - the conductivity required for antenna radiation;
  - the shielding effectiveness.
- *Dielectric coating* is aimed at providing
  - Mechanical protection;
  - Preferred attractive appearance.

What are the effects of the coating on antenna performance ?

2. Fundamentals

- The ***Most Interesting Parameters*** of coating (with regard to antenna performance) are:
  - The dielectric constant (also called permittivity) ε
  - The electrical conductivity: σ
  - The magnetic permeability: μ
- The ***Skin Depth*** is another important parameter, it is defined as:

$$\delta = \sqrt{2/\omega\mu\sigma}; \qquad \omega = 2\pi f.$$

  - The signal is reduced by 8.686dB over one skin-depth
  - Most currents are concentrated within one skin depth.

Properties of some materials (at 100 MHz)

Material	ε_r	μ_r	**σ (s/m)**
Fresh water	80	1	~ 0.01
Sea water	80	1	~ 4
Copper	1	1	57,000,000
Steel	1	~ 7,000	~1,000,000
Soil	~ 10	~ 1	~ 0.1
Glass	~ 4	1	~ 0.0001
Concrete	~ 8	1	~ 0.1
Wood	~ 2	1	~ 0.0001

Effects of Coating on Antennas

- The ***Most Important Parameters*** of antennas are
  - Input impedance
  - Radiation pattern
  - Gain and
  - Efficiency
- The coating may affect all these important parameters.
  - It changes the wavelength (due to ε), hence the resonant length, and the right size of the antenna;
  - It changes the input impedance, gain and efficiency;
  - It may also affect the radiation pattern.

3. Solutions?

- The coating properties are normally functions of frequency, they must be identified.
  - This is usually done by experiment;
- Taking these propertied into account when designing the antenna.
  - This can be done by numerical simulation. Commercial antenna design software are now of the capability.
  - Experiment can be conducted to validate the simulation.
- RF transparent coating?
  - Yes, like a radome; But this is normally possible for narrow band.