Modelling Thin Materials in CST STUDIO SUITE 2012

Lossy Metal

Ohmic Sheets

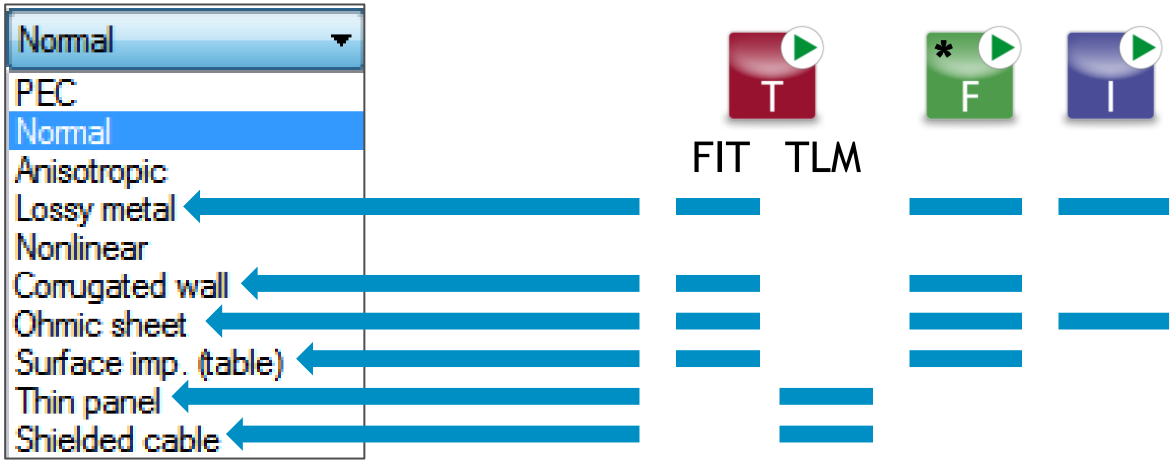
Tabulated Surface Impedance

Thin Panel

Various Material Types

Material types

Available in which solvers?



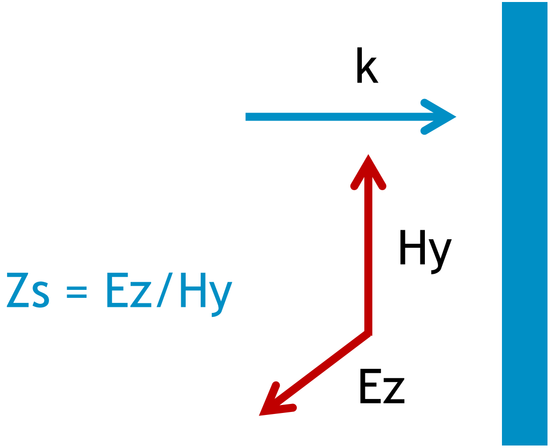
*Apart from "Lossy Metal", only available for tetrahedral mesh.

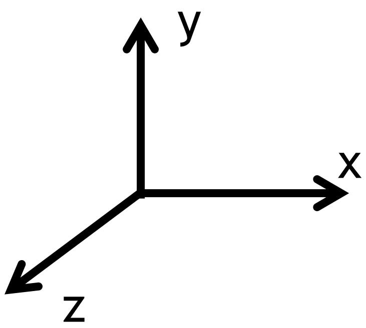
Surface Impedance Materials

- In principle a classical dispersive material could be used to model these materials.
- However, an excessively fine mesh might be needed:
  - if the object made of that material is too thin
  - if the penetration depth of the field into the object is very small
  - if the material consists of several relatively thin layers.
- The surface impedance model is a way to avoid a very fine mesh inside the material. Use one of these material types whenever the skin depth or the material's thickness is too small to model in 3D.

Principle of Surface Impedance Materials

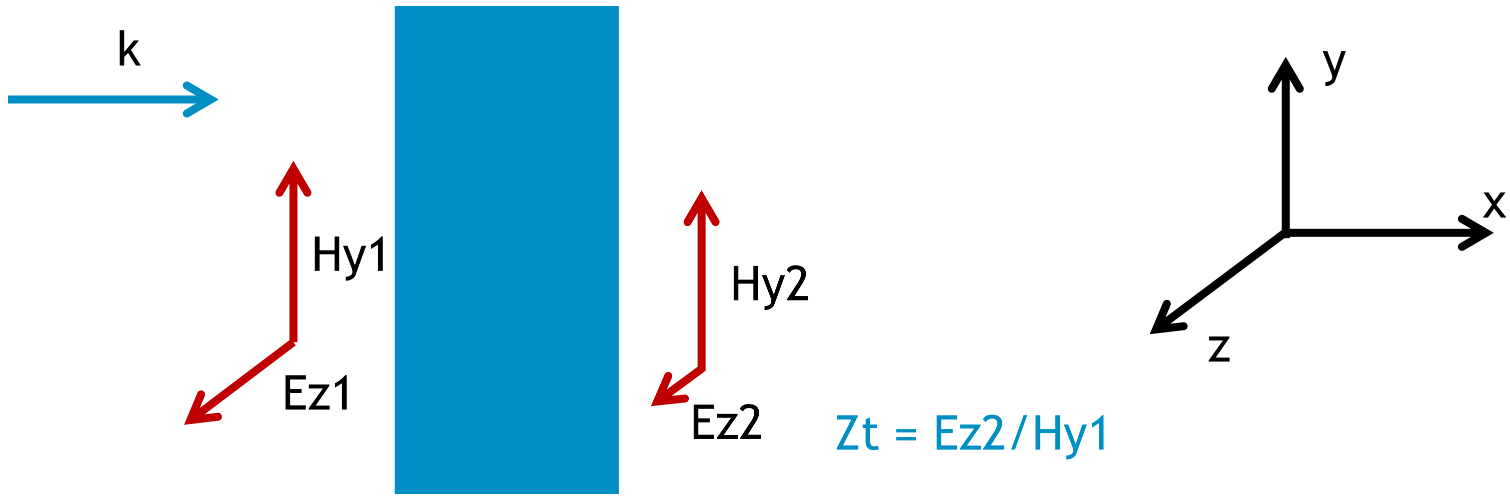
- A surface impedance formulation relates the tangential E and H fields at the surface of a material.
- The field inside the volume enclosed by the surface impedance is not computed (it is actually zero).





Extension of the Surface Impedance Model: Transfer impedance

A transfer impedance (Zt) model relates the E-field on one side of the material sheet to the H-field on the other side; thin panel model uses both Zs and Zt



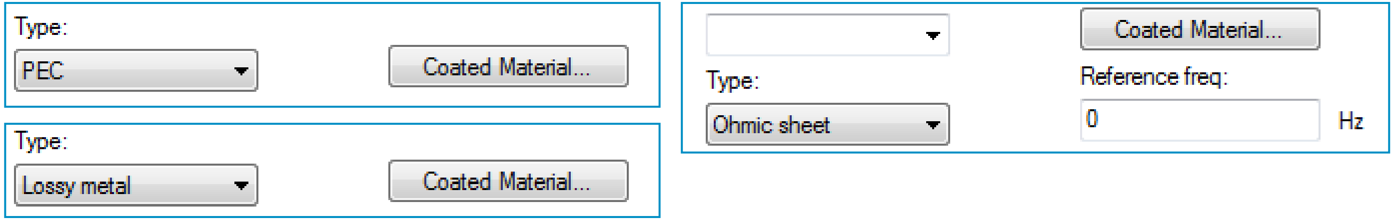
Transparency

- Some material types allow waves to “pass through” them if the object is infinitely thin. For a ***surface impedance material*** this means that the electric field on both sides of the material is the same.

- Lossy metal; corrugated wall: always opaque
- Ohmic sheet: transparent if infinitely thin (i.e. thickness = 0); opaque if the object has a volume
- Surface impedance: user’s choice if infinitely thin; opaque if the object has a volume
- Thin panel: transparent (has to be infinitely thin)

Coated Materials

- 3D (thick) object of certain materials can have a coating



- The surface impedance of the original material is analytically transformed to take into account the parameters of the coating layers.
- Coating layers: “Normal” type material, can be dispersive
- The result is an opaque surface impedance object (transparent only for infinitely thin Ohmic sheet).

Ohmic Sheet

- Use it if a constant surface impedance over the whole frequency range is needed (in the transient solver a first-order model is used).

- Typical applications:
  - IC simulation (the material parameters are often directly given in Ohms per square)
  - Realizing a non-Cartesian boundary in the frequency domain solver (fill everything unwanted with an Ohmic sheet material whose interior is not meshed)

Tabulated Surface Impedance

- Use this if the surface impedance is strongly frequency-dependent (in the transient solver a fitting of up to order 10 is used).

- Typical application:
  - Lossy layers used to absorb or attenuate an incoming wave which are too thin to be modelled in 3D

Coated Material

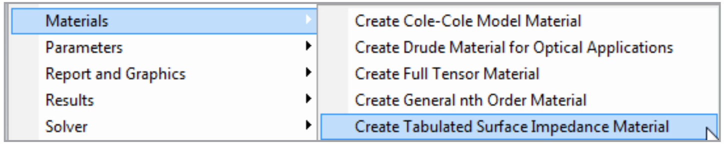
- Use this model for thin absorbing layers (dielectrics) placed on metallic objects, if the layers are too thin to be modelled in 3D, e.g. for dielectric-coated metals.

- Typical application:
  - Coating (e.g. RAM) on the surface of an airplane

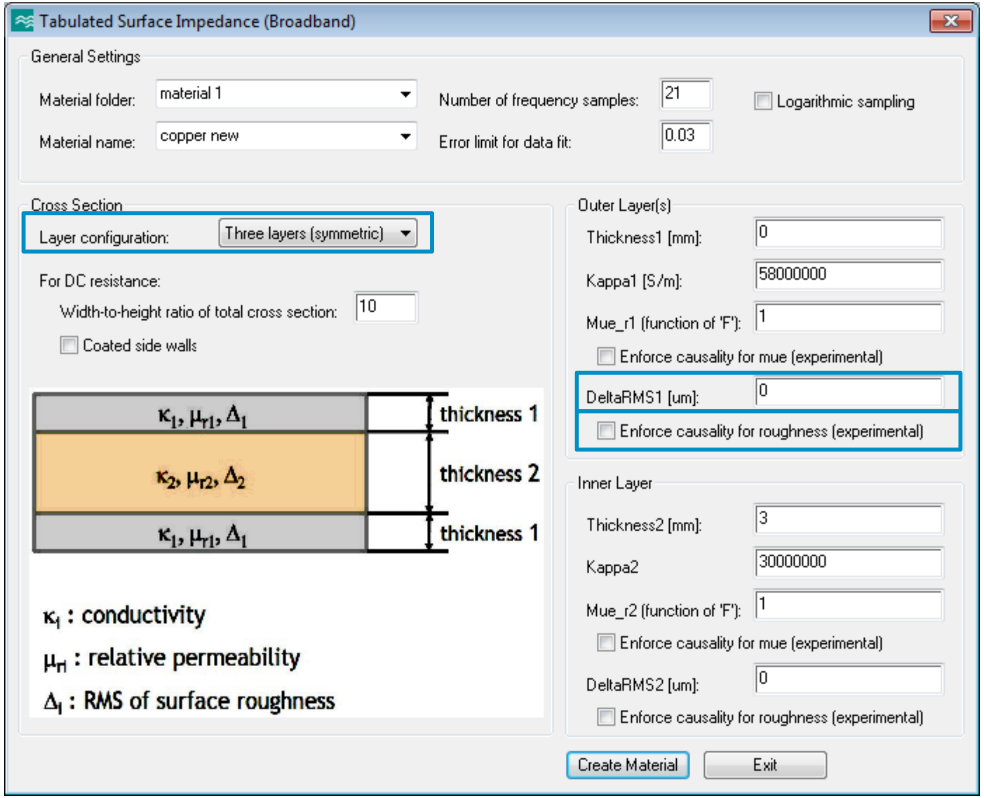
Surface Models for Metals Accurate at DC

- Lossy metal is only accurate at high frequencies.
- For accurate DC values, one could use a “Tabulated Surface Impedance” model with appropriate low-frequency and high-frequency tabulated values.

- The macro Materials ⇨ Create Tabulated Surface Impedance Material can be used for this.
- Moreover, it allows the definition of a *metallic* coating (the “Coated Material” type only allows dielectric coatings)

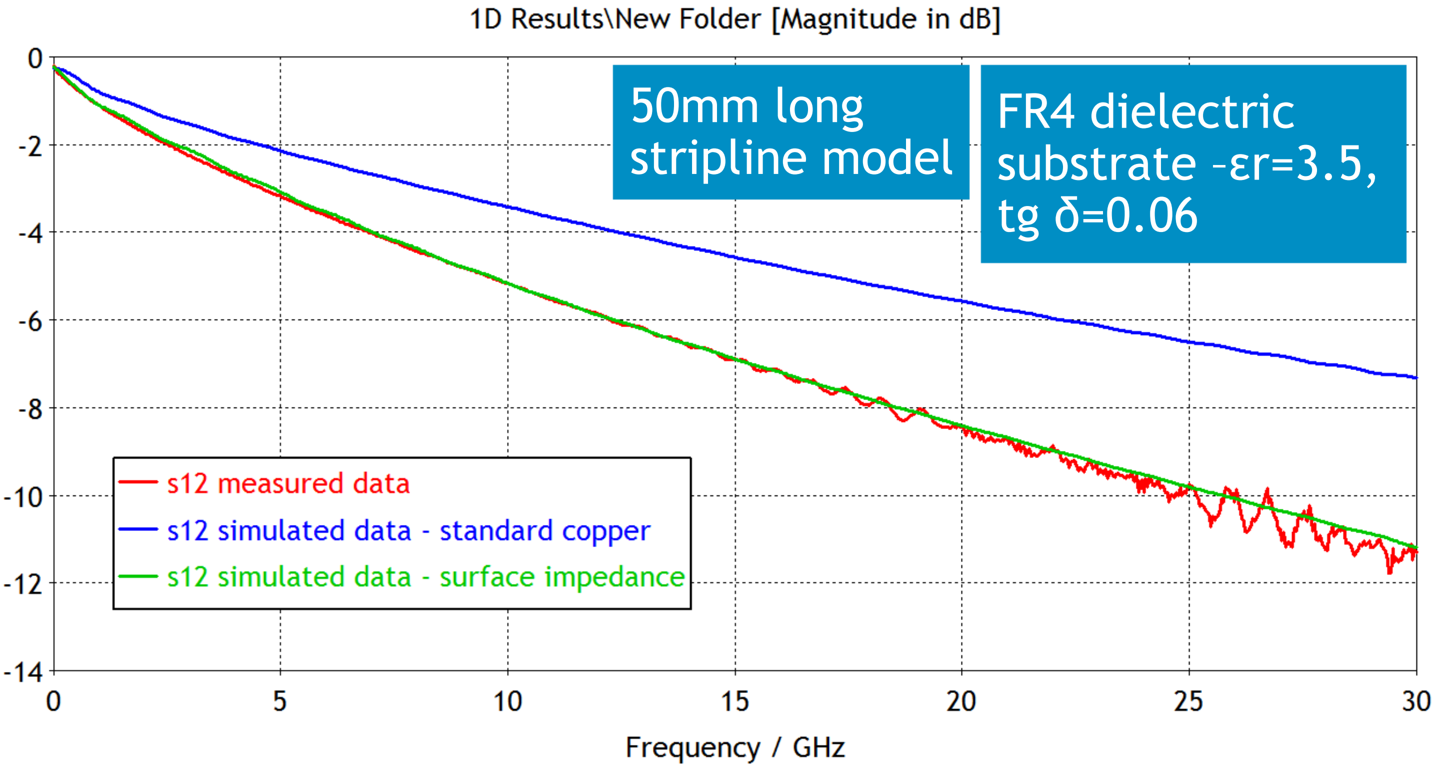


Macro: Tabulated Surface Impedance



- Surface impedance for multilayered structures
- Surface roughness
- Causality enforcement

Example (Surface Roughness Required)



Summary

- Metal with losses: “Lossy metal”
  - Accurate at DC: macro
- Thin lossy dielectrics (also user-defined metals)
  - Frequency independent: Ohmic sheet
  - Dispersive: tabulated surface impedance
- Coating on metallic objects
  - Dielectric coating: “Coated material”
  - Metallic coating: macro

- 3D objects and lossy metals are opaque.
- Thin ohmic sheets are transparent.
- Thin surface impedance materials can be defined as opaque or transparent.

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