Validation Report

Name of Report	A validation of the ability of OmniSim to model magnetic materials
Performance Date	13 November 2007
Performed By	Klearchos Chaloulos
Product Name	OmniSim / CrystalWave
Product Version & Compile Date	Version 4.2
References	
External Files	Permeability.prj

A validation of the ability of OmniSim to model magnetic materials

Outline

We will perform two simple tests to demonstrate that OmniSim can model materials with magnetic permeability not equal to 1. The first test is just a validation of the Fresnel reflection at the interface between two materials of equal permittivity but different permeability. The second test is a measurement of the reflection at the interface between two materials with the same impedance but different permittivity and permeability values.

Test 1 – Reflection

The first structure is simply an interface of air with a magnetic material of epsilon=1 and mu=9. The impedance of this material is $1/3*Z_0$, where Z_o is the impedance of vacuum. Therefore we expect a reflection $R=\left(\frac{0.333-1}{0.333+1}\right)^2=0.25$. The structure can be seen on Fig. 1, where permeability is plotted. The top and bottom walls are electric, so that the problem is a simple plane wave reflection. Fig 2 shows the reflected power, which is very close to 0.25.

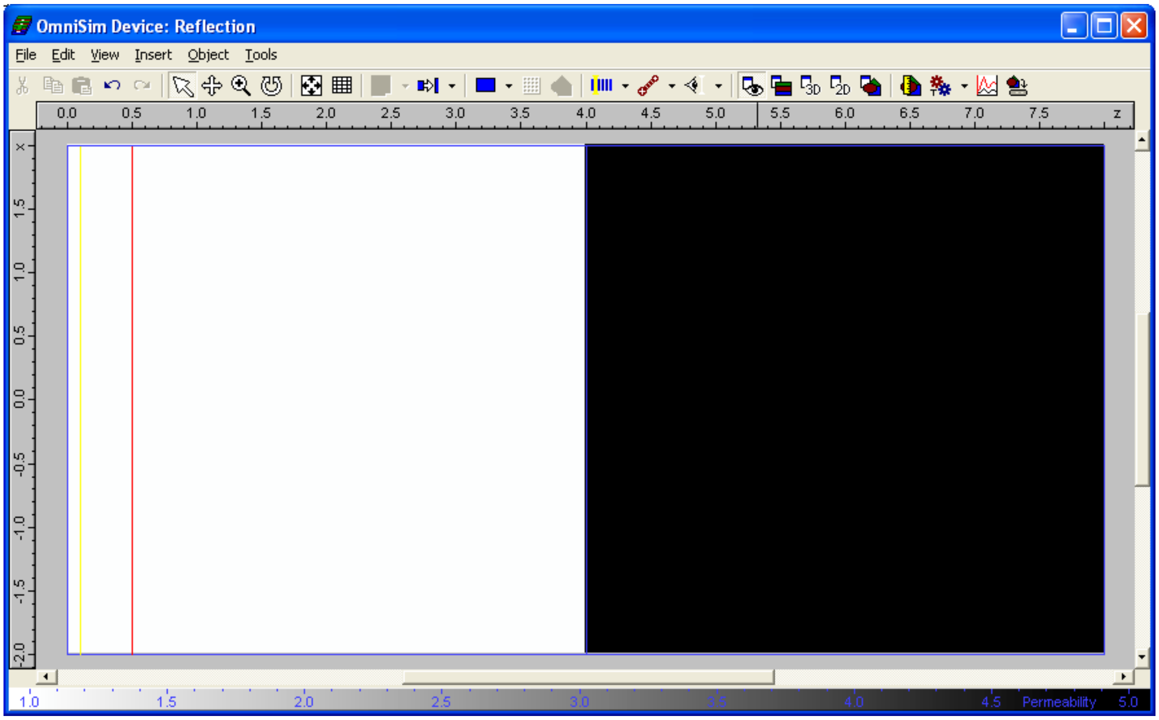

Figure 1: Structure used for the first test, permeability plotted. White is 1, black is 9.

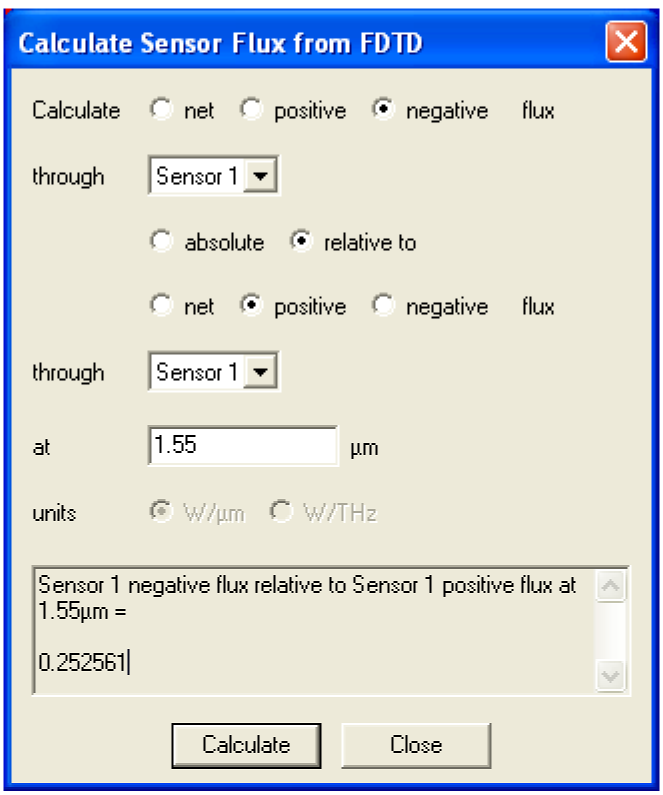

Figure 2: Reflected power. The reflection is 0.252561, very close to the expected 25%. Grid size=0.02um, duration 8192 time steps.

Test 2 - Impedance matching

For the second test we create an interface between two materials so that, although they have different permittivity, no reflection occurs. To do that, we make their impedance to be equal. Impedance is $Z = \sqrt{\frac{\varepsilon}{\mu}}$. We set the permittivity of the first material to 4 (equivalently we set the refractive index to 2 in OmniSim) and the permittivity to 0.25. The permeability of the structure can be seen in Fig. 1.

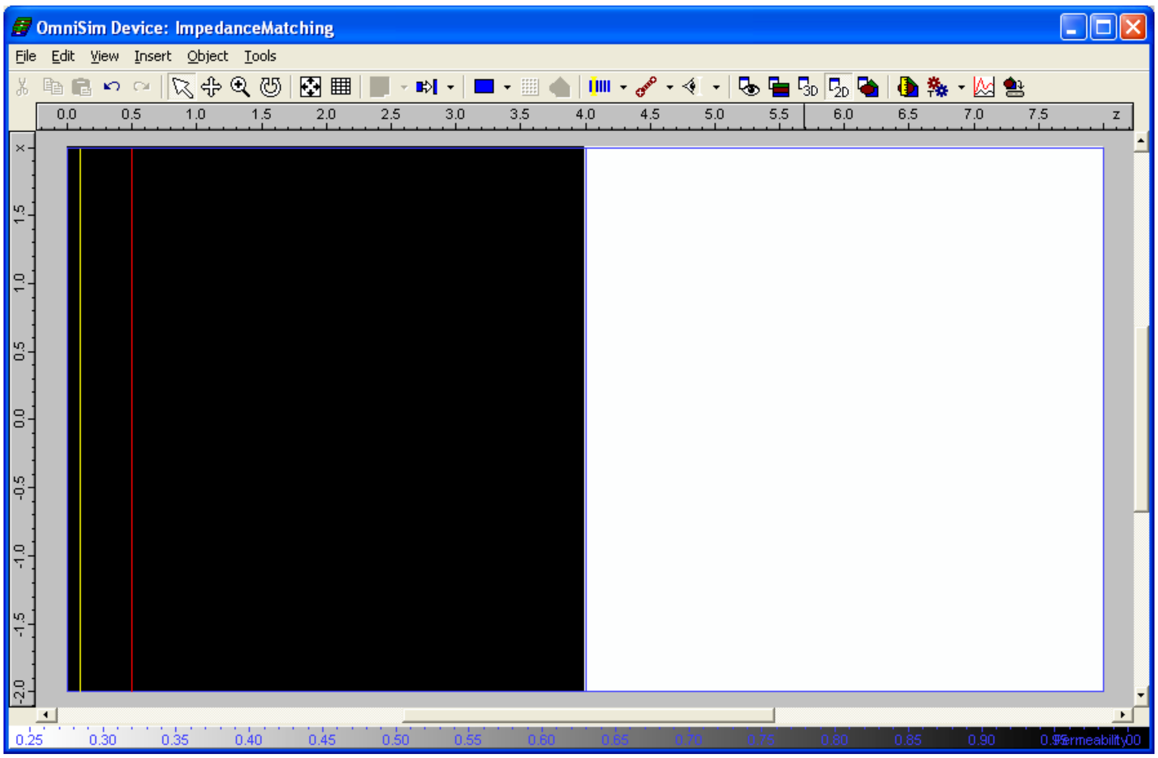

Figure 3: Permeability of the impedance matched structure. Black is 0.25, white is 1.

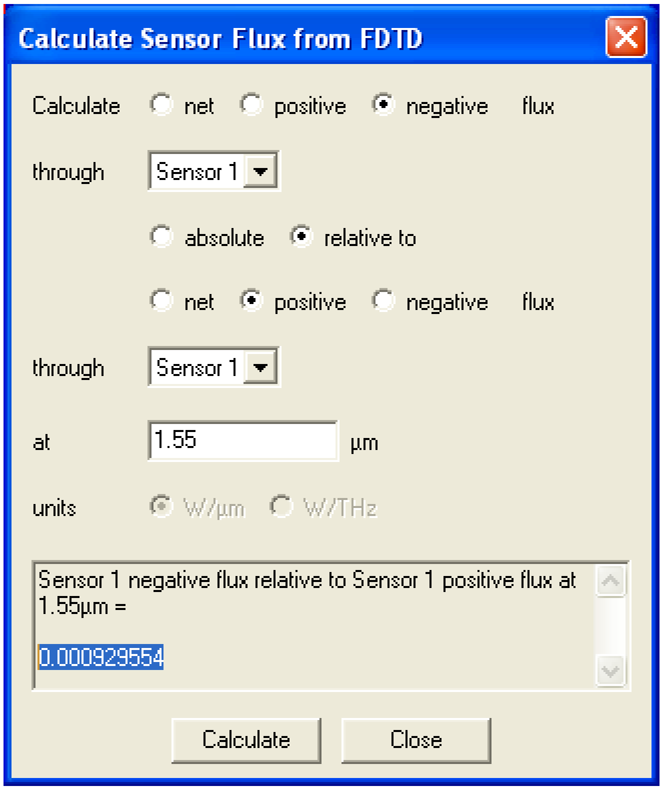

Figure 4: Reflection obtained from the impedance-matched structure. We see that it is very small, less than 0.1%, as expected. Grid size=0.2um, duration=8192 time steps