Thermal and Solid-Mechanics FEM Simulation of a Microwave Spatial Power Combiner Amplifier

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Introduction: This study describes the Thermal and structural combined simulation of a Microwave (MW) Fin Taper (FT) Spatial Power Combiner (SPC) Power Amplifier (PA), based on rectangular Waveguide (WG).
The power dissipation of the active devices induces a thermal expansion which can alter the SPC desired Electromagnetic (EM) behavior.

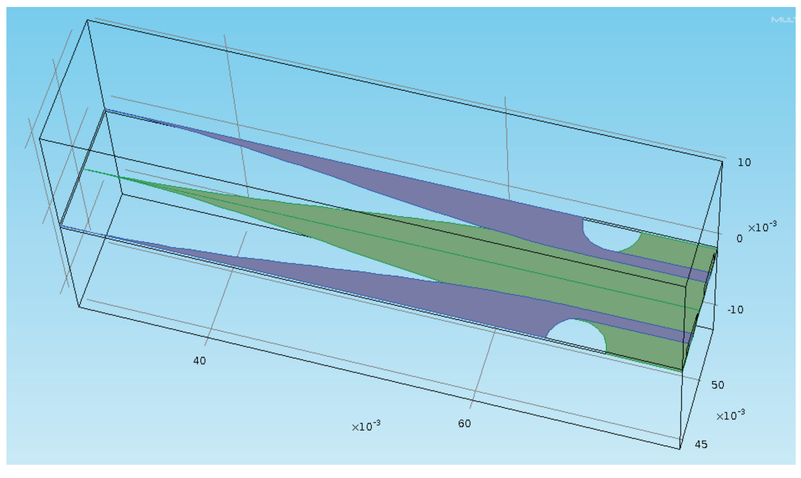

Figure 1. A single card which contains a dual FT inserted in a rectangular WG.

Computational Methods: In order to optimize the computational resources, the analyzed structure consists in a quarter of WG in which two carriers are inserted. Driver and ended stage transistors are been considered as different heat sources. Symmetry boundary conditions have been employed.

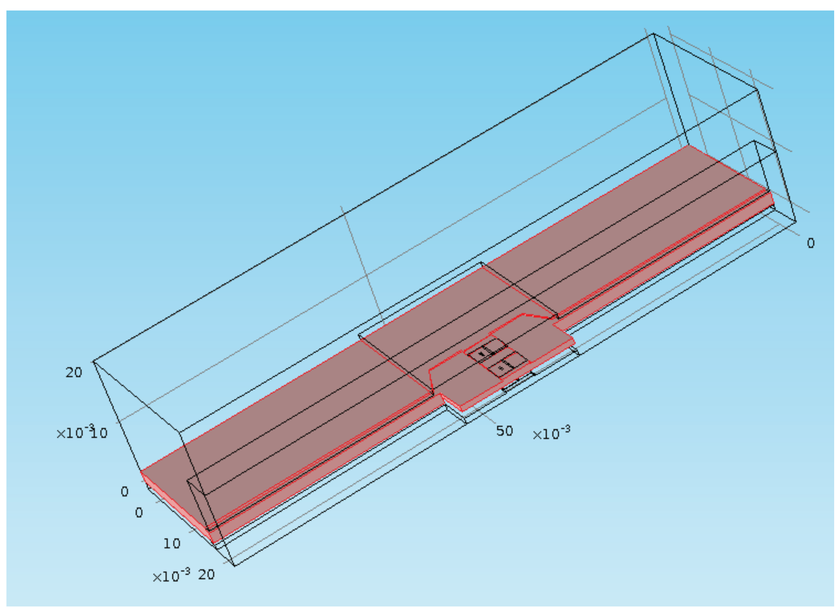

Figure 2. Analyzed structure: One carrier is highlighted in red. In the center are placed two active devices. The combing structure has to be inserted, parallel to the carrier, in the smallest parallelepiped which represents the air in the WG.

Results: We have imposed a power dissipation of 20 W for each of the 16 GaAs active devices, considering their conversion efficiency.

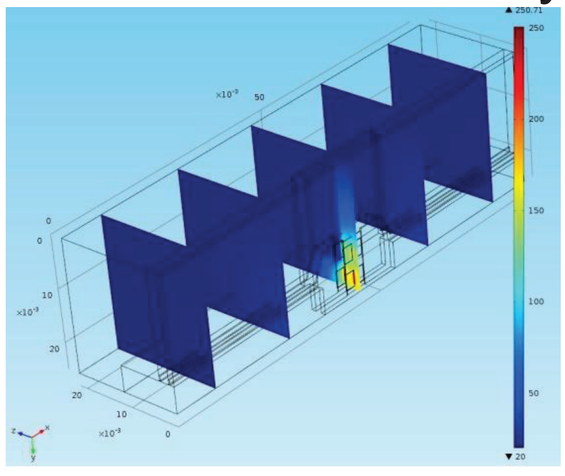

Figure 3. Temperature, with Aluminum carriers

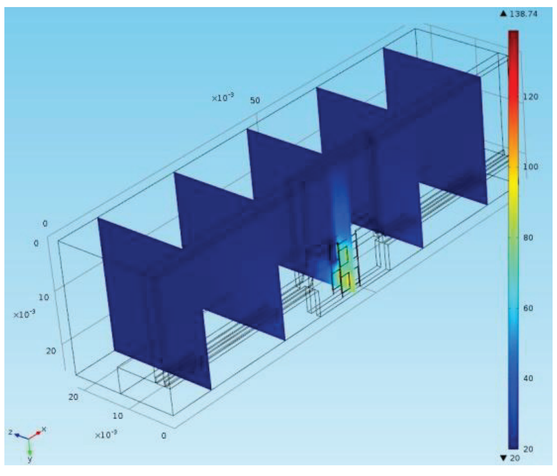

Figure 3. Temperature, with Copper carriers

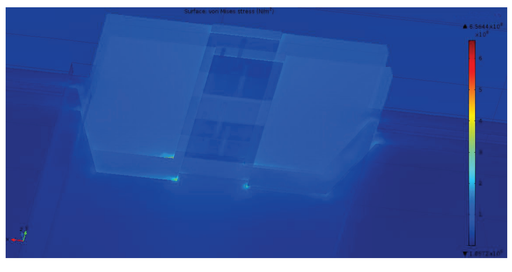

Figure 4. Stress, with Copper carriers

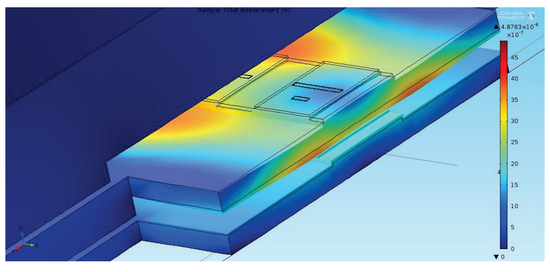

Figure 5. Displacement, with Copper carriers

Copper carries allows a better heat sinking, but the displacement value is incompatible with the GaAs survivability: for such reason, an interface layer is needed between the back of the GaAs MMIC and the copper carrier: used materials are CuW or CuMo.

Conclusions: This study allows the proper thermo-mechanical design for such amplifiers, so that proper materials for carriers and interfaces have been chosen.

References:

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