Multiphysics Analysis of a 130 GHz Klystron

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Abstract

Klystrons are widely used vacuum tube amplifiers, well suitable also as oscillators [1-2] that use interaction of electron beam with resonant cavities to generate high power (kW) signals at high microwave frequencies with large bandwidths [1], overcoming solid-state device lacks[2].

The multiphysics analysis of a 130 GHz klystron is described in this paper. The proposed device uses a micro machined input section described in last COMSOL Conference appointment in 2015 in Grenoble [3]. Here, the evolution of the system in a complete klystron is shown and some considerations are discussed on the feasibility of over 100 GHz klystrons.

In millimeter waves applications, very small beam dimension [4] and layout dimensions [3] are required making the electromagnetic behavior critically influenced by multiple physics factors related to heating effects and power dissipations.

The device is based on a structure of cold cathode and cavity system integrated on a silicon background.

A multiphysics analysis using COMSOL® software has been employed to ensure the future correct operation.

Performing a thermos-mechanical analysis, coupling Heat Transfer (ht) and Solid Mechanics (solid) interfaces, temperature and deformations have been determined when the heat generated by the cathode power dissipation has been diffused to the system, cooled by an opportune airflow. On the deformed geometry, the axial electric field has been computed through the Moving Mesh (ale) dedicated interface [5].

Scattering parameters at the input and output ports and axial electric field have been calculated by means of opportune computational strategies that have allowed for the implementation of simple but reliable model.

Reference

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Figures used in the abstract

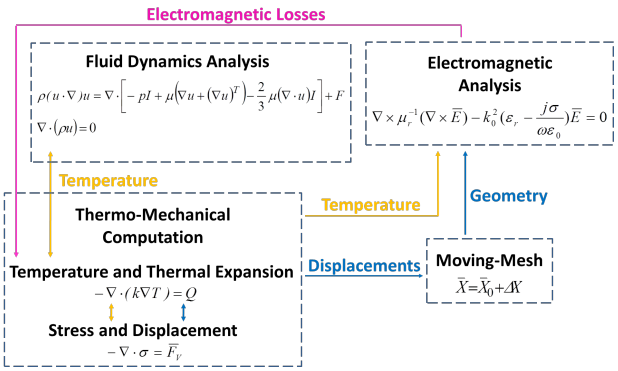

Figure 1: Computation Logical Diagram

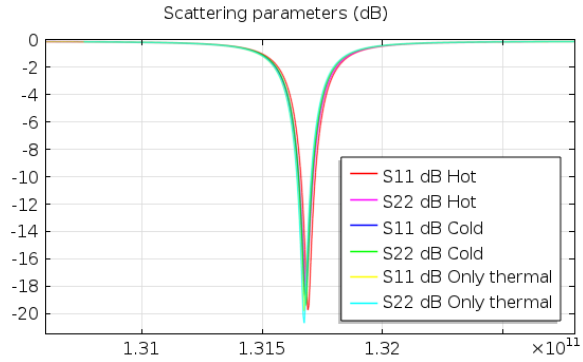

Figure 2: Scattering parameters (dB)

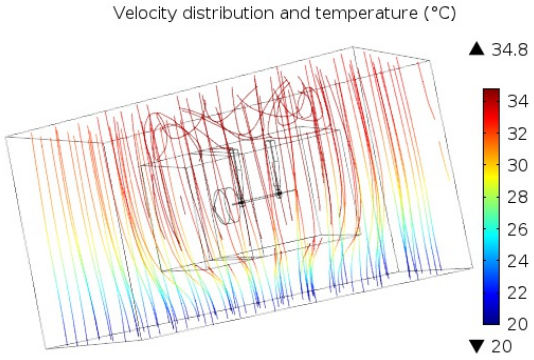

Figure 3: Velocity distribution and temperature (°C)

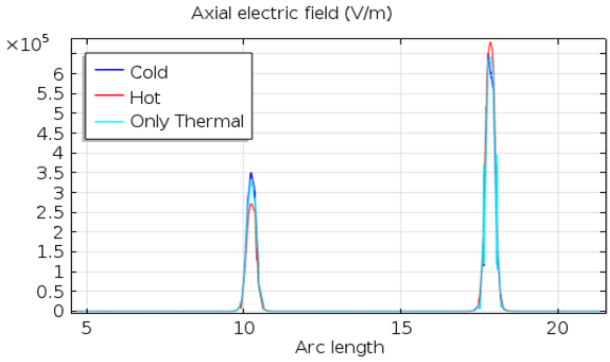

Figure 4: Field distribution