INTRODUCTION:

- Mid-IR photonics is growing thanks to advances in Lasers, QC-Lasers, MEMS gratings and fiber optics [1]
- Temperature is the key to stable and reliable operation of photonics systems [2]
- Thermal management and packaging design can be handled with multi-physics FEM models.

PACKAGING STRATEGY of Mid-IR laser:

- Heat-spreading submount to efficiently remove heat
- Thermo-electric cooler (TEC) below heat spreader
- Kovar package to reduce thermo-mechanical stress and enable hermetic sealing

Thermo-electric Cooler (TEC) model:

- Use of COMSOL® Application
- Improved Mesh approach to cope for large model with 12x24 pellets
- TEC model calibrated with supplier material data (Seeback, k, other...)
- Calibrated TEC model comparison with lumped-model simulator. Heat flux accurate to >99%

Kovar package COMSOL model:

- Conjugated heat transfer (air sealed in Kovar package)
- Convective and Radiative effects from external package
- Multi-physics coupling also to Thermo-electric cooler (TEC)
- Parametric analysis to find optimum laser peak temp.
- Iterative solver found optimal (segregated approach)

Comsol simulation results:

- Optimal set of submount parameter minimize laser temp.
- Optimal laser mount position
- Impact of reference heatsink and ambient temperature
- Transient simulation to check thermal time-constants

Example of stationary results:

- Sealed air (slice)
- Slice “Color Table”
- 2450K Elements
- TEC: Δtmax ~71(K), Qmax ~ 56(W)
- 120K Elements
- Avg. Element Quality is 0.99 (Skew.)
- 9 independent parameter sets
- 112h solution time (high res.)

Example of transient results:

CONCLUSIONS:

- Laser mounting position on submount is critical to achieve minimum laser peak temp.
- Heat spreader thickness plays an important role. Thickness of 2.5-4.5(mm) is optimal
- TEC must be on if laser is active (risk of damage)

REFERENCES:

1. MIRPHAB is an all-services integrated Pilot Line for the development of MID-IR photonics sensors in Europe. [http://www.mirphab.eu/]