FEA of ion energy deposition on TCSPM prototype

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Introduction

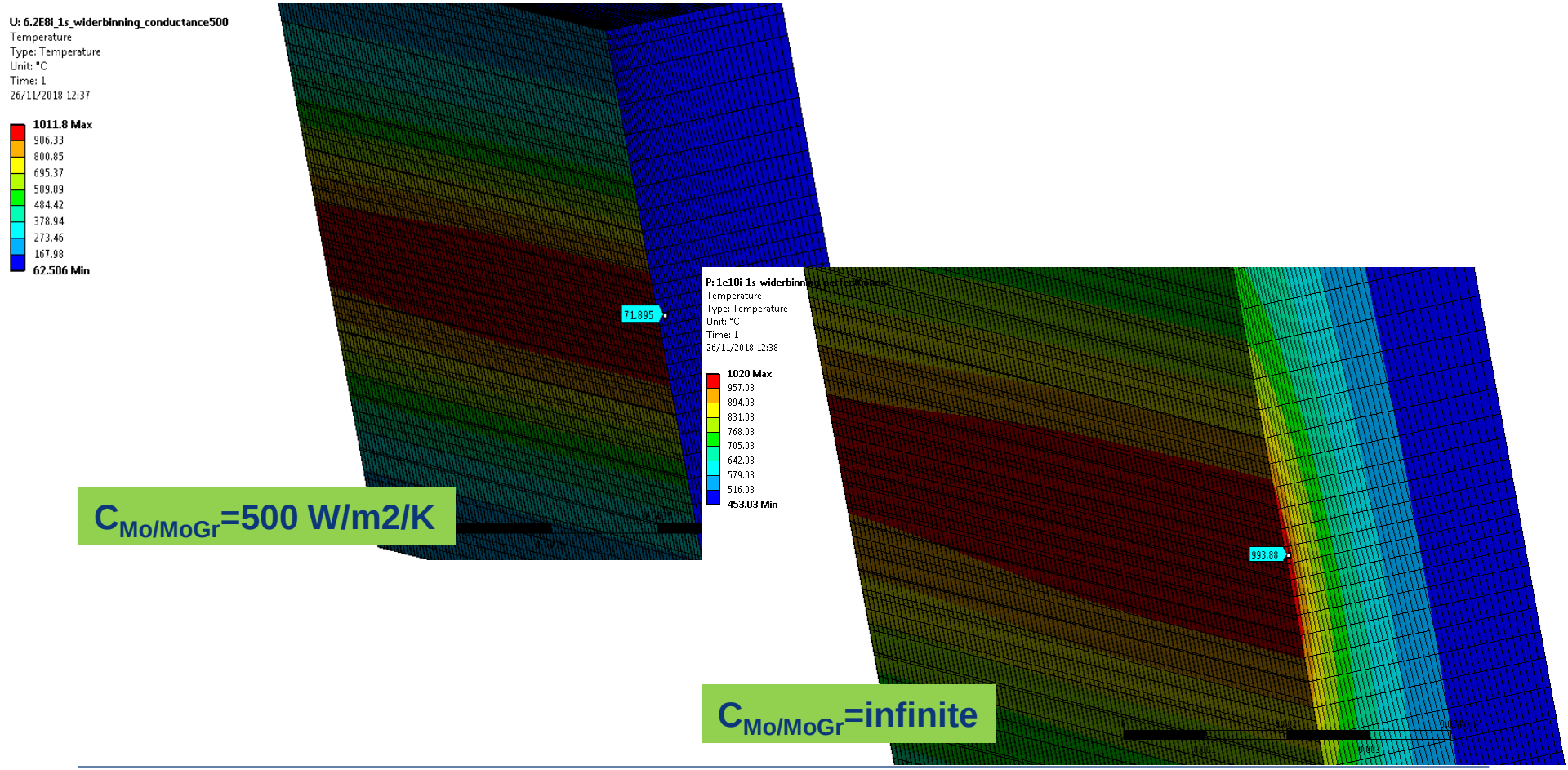
- Fluka maps from Anton**: ion beam deposition on a MoGr bulk coated with 5 micron of Mo** (real TCSPM prototype: 8 micron. We will see later why this difference is not very relevant, at least for ANSYS!).
- ANSYS: we considered a **constant power distribution over time (total energy and time conserved)**.If needed, a more realistic power profile can be evaluated after downselection between the several cases studied.
- Material properties as a function of temperature
- Several calculations performed to find what is the deposited ion intensity which leads reaching temperatures of 500 and 1000 °C in the coating, as a function of deposition time and thermal conductance at the interface Mo/MoGr

Thermal conductances

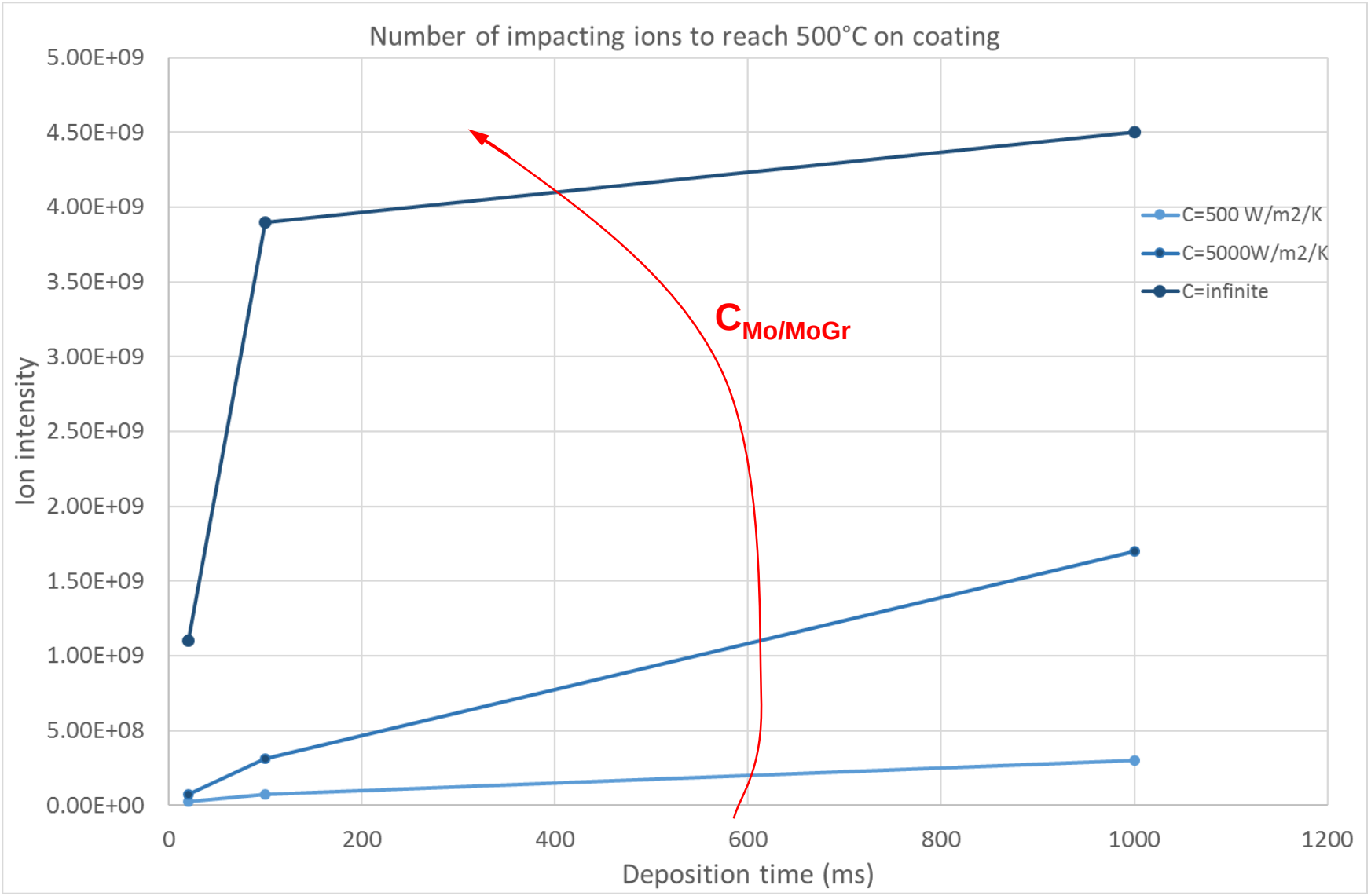
- Considerations here for values at room temperature
  - **Mo coating (5 µm):** the coating thermal conductivity is unknown. Let us assume the nominal value for Mo bulk (140 W/m/K) and 5 µm instead of 8 --> **C_{Mo}=2.8E7 W/m2/K**
  - **Mo/MoGr interface**: this value is unknown. Calculations run for **$C_{Mo/MoGr}$=500, 5000 W/m2/K and infinite interface conductance** (for comparison: brazed interfaces are between 5000 and 50.000 W/m2/K, clamped ones easily reach 10.000 W/m2/K)
  - **MoGr bulk (25 mm)**: thermal conductivity of MoGr is 50 W/m2/K in the transcerse direction --> **C_{MoGr}=2000 W/m2/K**
- Conclusions from this:
  - Even with 8 micron of Mo, or bad Mo conductivity, the **thermal resistance of the coating is irrelevant**
  - **Dominated by the bulk or, in case of bad contact at the interface, by the interface**
  - Some estimations on Mo/MoGr interface conductance at the end of the presentation

Results

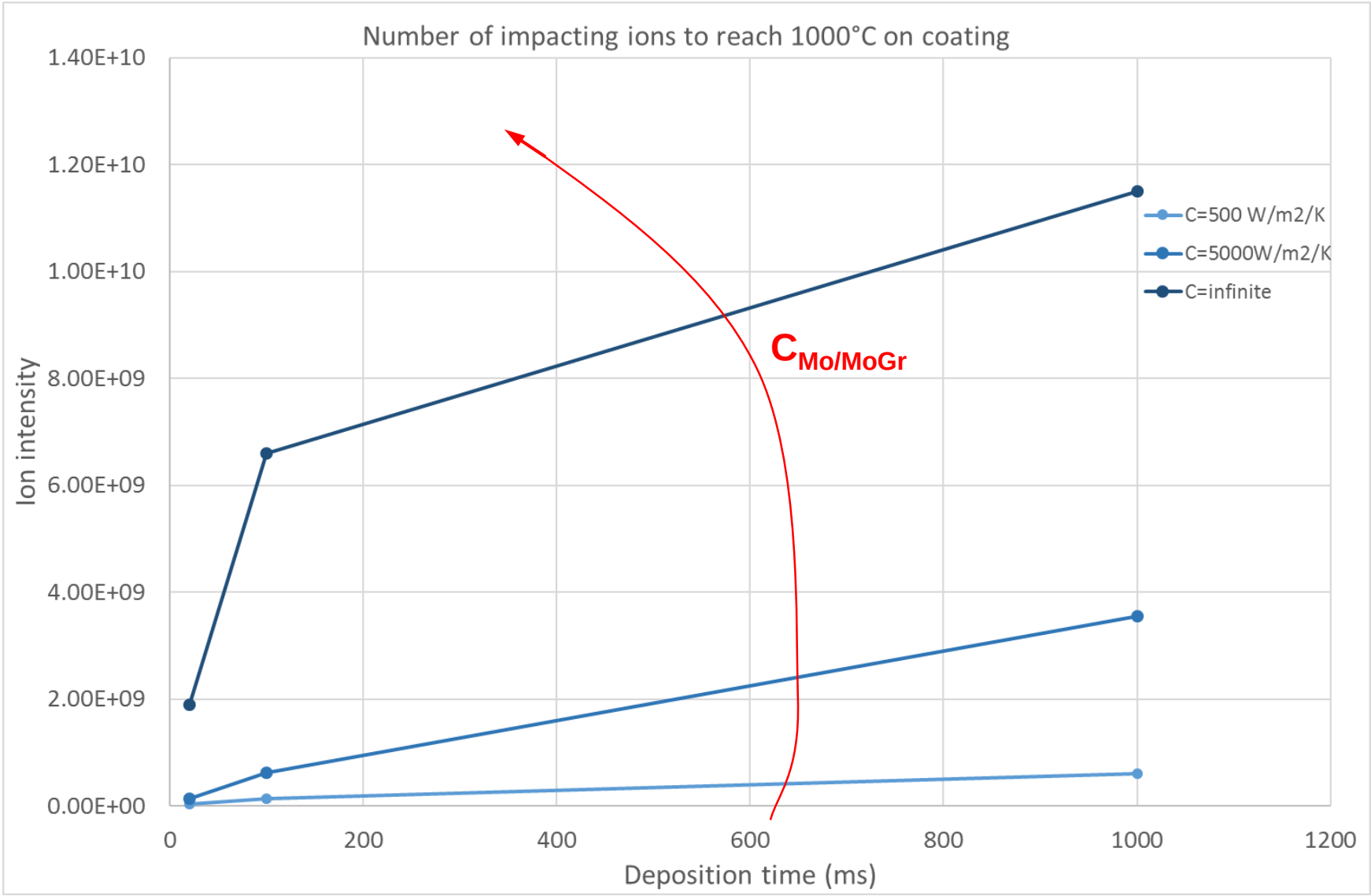
- Conductance at the interface very relevant



Results: intensities for 500 °C

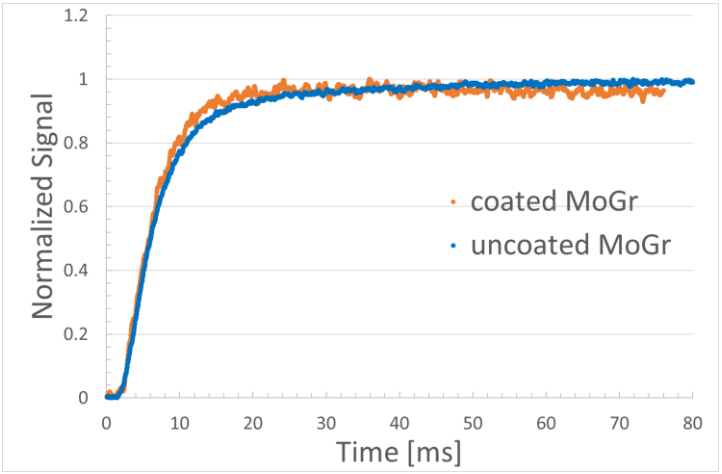


Results: intensities for 1000 °C



Thermal conductance at the interface

- Real value never measured, but some considerations could be done to tentatively estimate the order of magnitude
- Tests by C. Accettura with LFA method on 1 mm samples in MoGr coated with 6 µm
- Again:
  - **Mo coating (6 µm): C_{Mo}=order of 1E7 W/m2/K**
  - **Mo/MoGr interface**: unknown
  - **MoGr bulk (1 mm)**: **C_{MoGr}=5E4 W/m2/K**
- Results controlled by the bulk (no effect of coating and interface on the results!) → **$C_{Mo/MoGr}$ > (or ≫) C_{MoGr}**



Conclusions

- Results depend on **thermal conductance at the interface**
- Calculations done for three condictions: very bad contact (500 W/m2/K), intermediate contact (500 W/m2/K), perfect contact (infinite conductance)
- Real value hard to estimate, however, for a good coating one could expect having values of a magnitude simular to a brazing (order of 1E4 W/m2/K)
- Tests done with the laser flash on a similar interface would confirm that we are around this value or better, so likely **better than our intermediate case**.
- However, for the TCSPM proto:
  - Coating was thicker
  - Surface preparation was different (CO_2 blasting; improved in the last two years, now US+firing)
  - It stayed two years in the machine (maybe degradation of the conductance?)
- If the aim of the test is to stay below the damage threshold, one probably should look at the intensities of the **very bad contact case**.

Thanks for the attention!

Results

1000 ms			
Temperature (°C)	C=500W/m2/K	C=5000W/m2/K	C=infinite
500	3.00E+08	1.70E+09	4.50E+09
1000	6.00E+08	3.55E+09	1.15E+10
100 ms			
Temperature (°C)	C=500W/m2/K	C=5000W/m2/K	C=infinite
500	7.00E+07	3.10E+08	3.90E+09
1000	1.30E+08	6.20E+08	6.60E+09
20 ms			
Temperature (°C)	C=500W/m2/K	C=5000W/m2/K	C=infinite
500	2.20E+07	7.00E+07	1.10E+09
1000	4.00E+07	1.30E+08	1.90E+09