Study of Vacuum stability and desorption processes at low temperature for various FCC-hh candidate materials.

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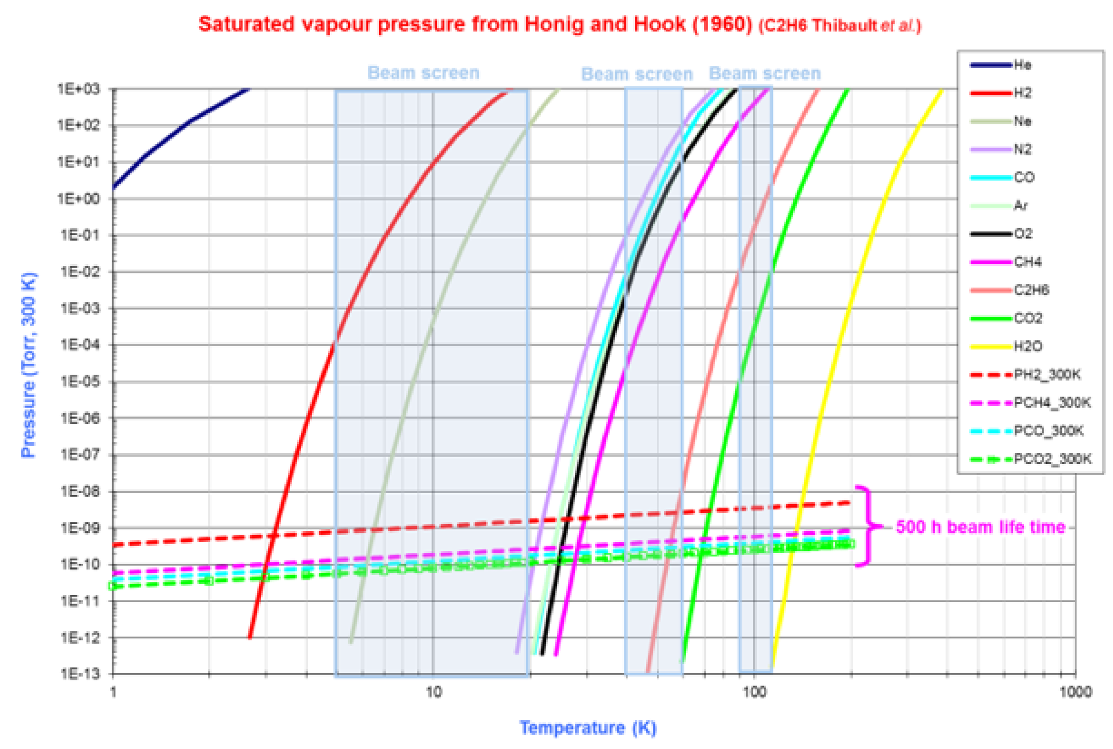
Introduction

One of the many important parameters to be studied and fixed in the design of the FCC-hh is the operational temperature (T) at which the foreseen beam screen should operate. Such choice will necessarily be a compromise between the desire to reduce cooling costs (keeping it at as close as possible to room T) and to have a minimal wall resistivity. The final chosen T must than cope with other constrains, one being vacuum stability even in case of tiny and unavoidable wall temperature fluctuations. In such cases, residual gases adsorbed on the wall should not undergo desorption processes. Vacuum stability will than be assured once the operating T $\pm$ ΔT will be kept safely far from adsorption/desorption T. This T depends on the gas species and, possibly, on material morphology [1,2,3].

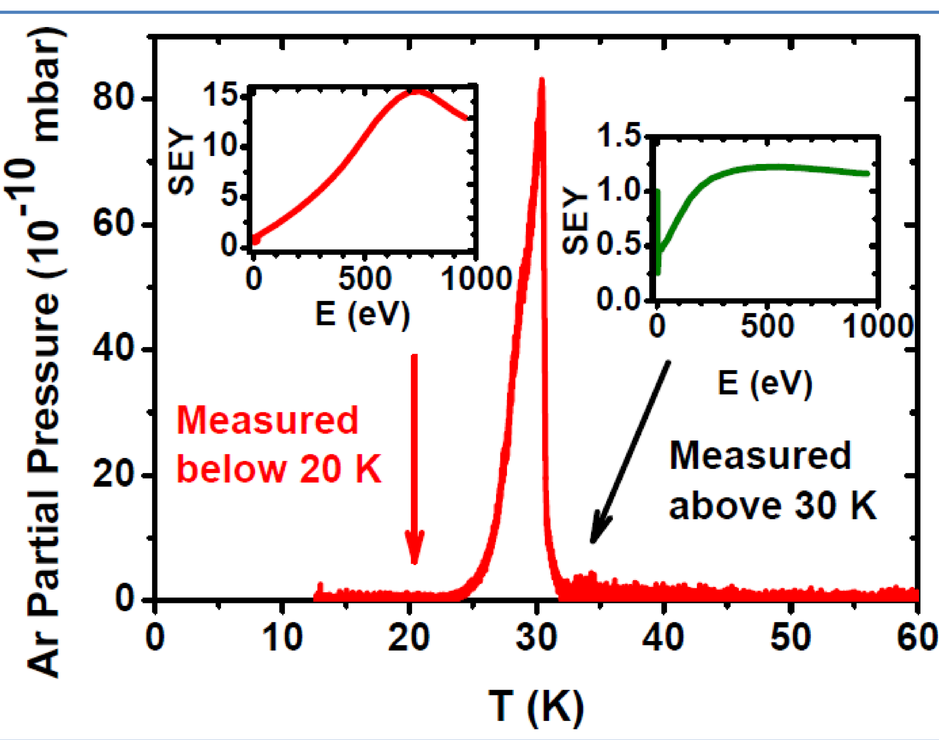


Experimental

Ar ice was grown at T= 15 K on clean Cu and on a representative sample belonging to the family of laser treated Cu (LASE-Cu [4]) available within the EuroCircol collaboration. Three different Ar coverages were considered: 16L, 4L and 1L. Desorption processes were studied as a function of T by using a quadrupole mass spectrometer (Hiden, HAL 3F PIC) and Secondary Electron Yield (SEY).

Thermal desorption curve obtained in the representative case of 16 L of Ar on a clean Cu substrate. SEY measured below 20 K is the typical SEY of 16 L Ar on Cu. SEY measured above 30 K is the typical SEY of clean Cu showing that Ar is fully desorbed.

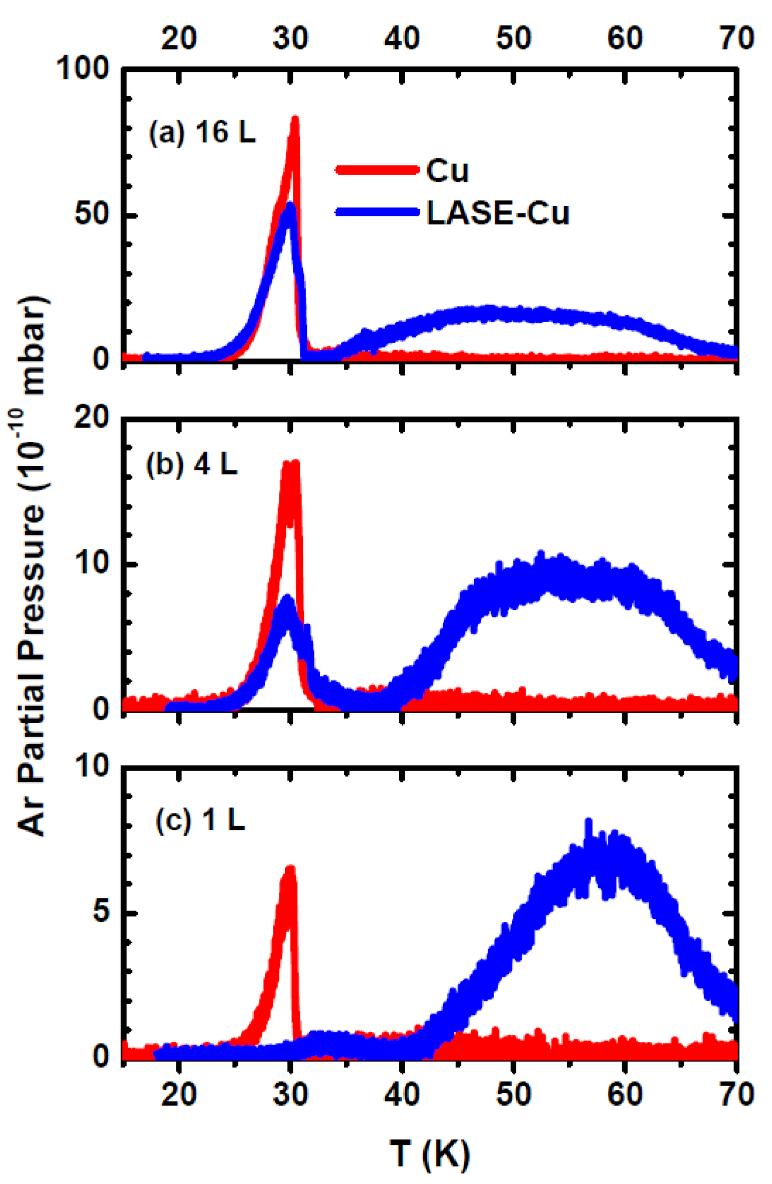
- The desorption occurs within the T range in which the SEY decreases down to the Cu value. This allows one to attribute the peak at ~ 30 K only to the Ar desorption .



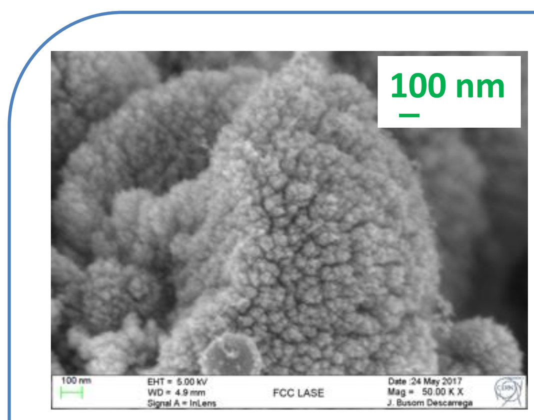
SEY vs T

SEY measurement during the desorption process acts as cross-check for interpreting the thermal desorption curves

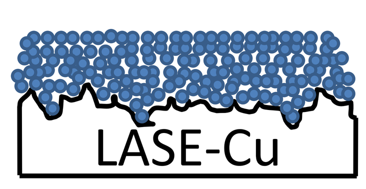
Argon Desorption



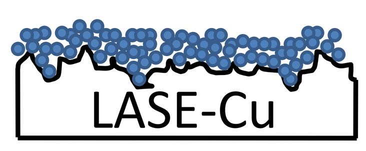
- On flat Cu Ar adsorbs due to the weak Ar-Cu and Ar-Ar Van der Waals interactions and the desorption curve consists of the sharp peak at T~30 K.
- For the LASE-Cu substrate the Ar adsorption energy at the undercoordinated surface defect sites increases and desorption occurs at higher T. However, at high coverage, multilayer desorption at T~30 K is also observed.



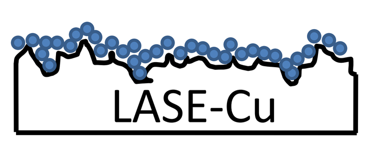
Morphology of LASE-Cu sample by SEM [4]
Surface highly inhomogeneous at the nanoscale



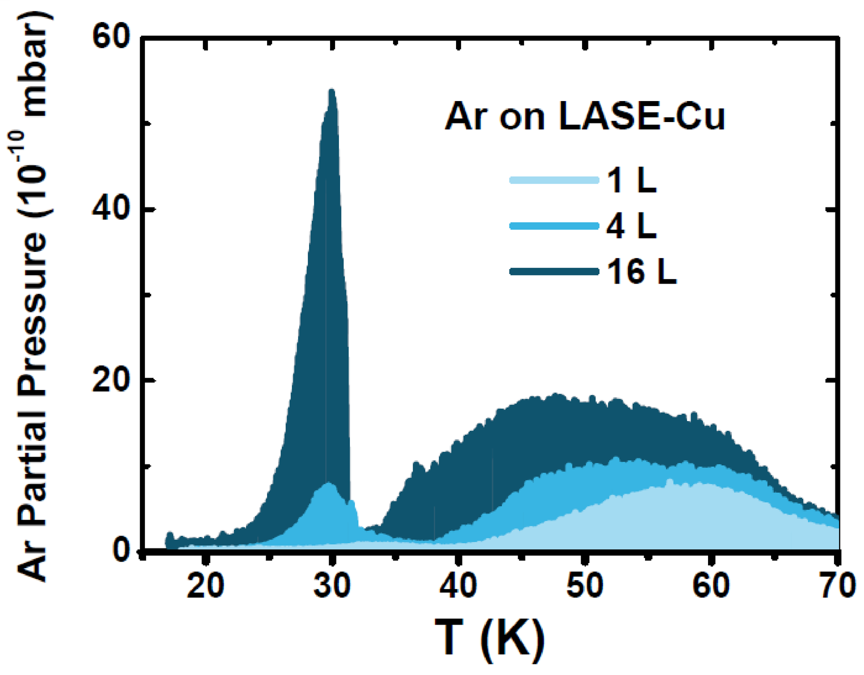
Ar-Ar interaction is dominant



Ar-LASE surface and Ar-Ar interaction contributes as well



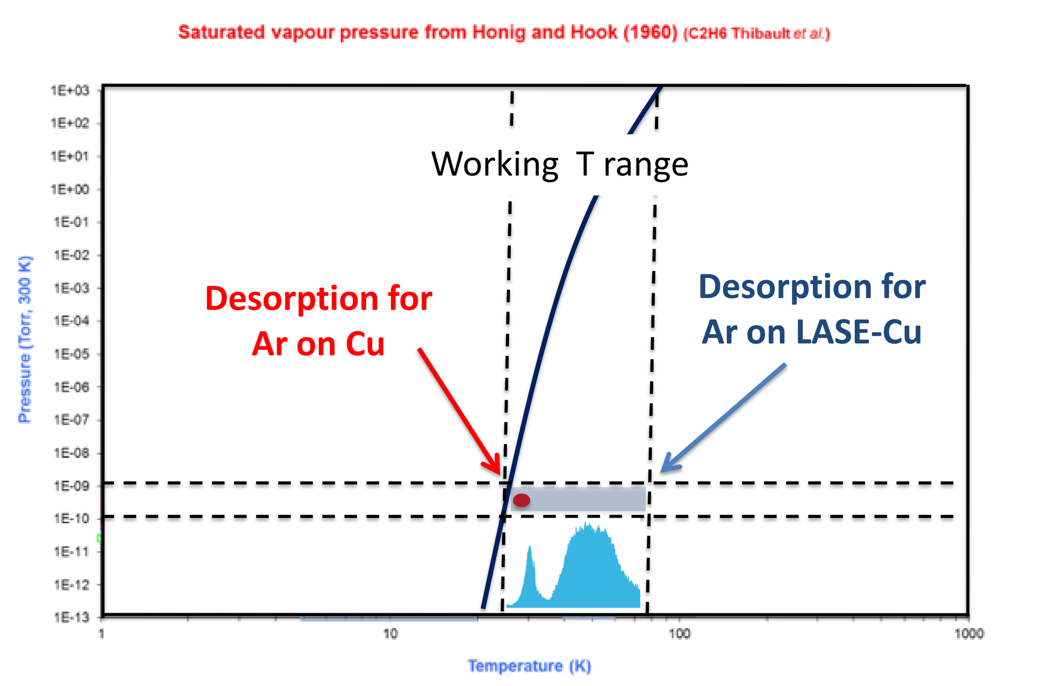
Predominant effects of the undercoordinated surface morphology



- The desorption T is higher due to the dominant contribution of Ar-LASE surface interaction
- The desorption T is wide, likely due to the intrinsic spread in adsorption sites on the nanostructured surface

Conclusions

When Ar ice is grown onto a strongly morphologically modified surface, only thick ices behave as expected. At low/intermediate coverages, the Ar desorption takes place in a much vaster and higher T interval.



This evidence may suggest a critical dependence of vacuum stability on surface morphology, gas species and dose, thus requiring further investigation.

References

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