Benchmarking of Surface Conditioning

–

Problems of current technology & possible future development routes for electron cloud mitigation

Marcel Himmerlich on behalf of TE-VSC

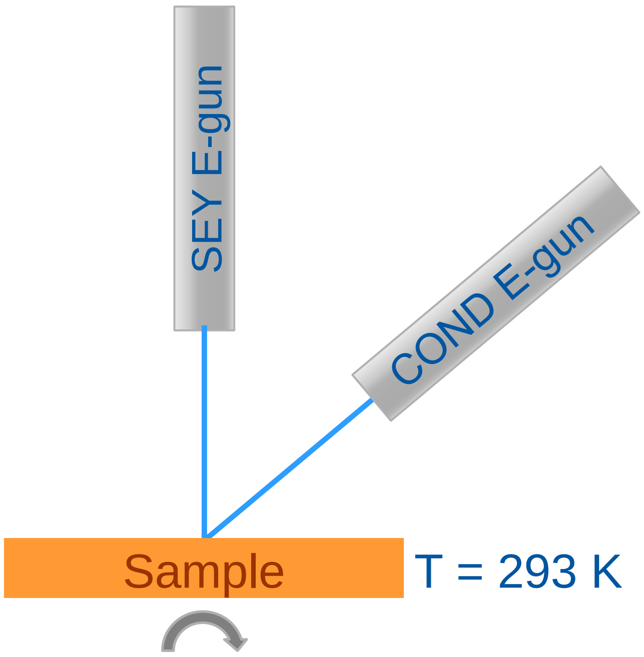
Motivation

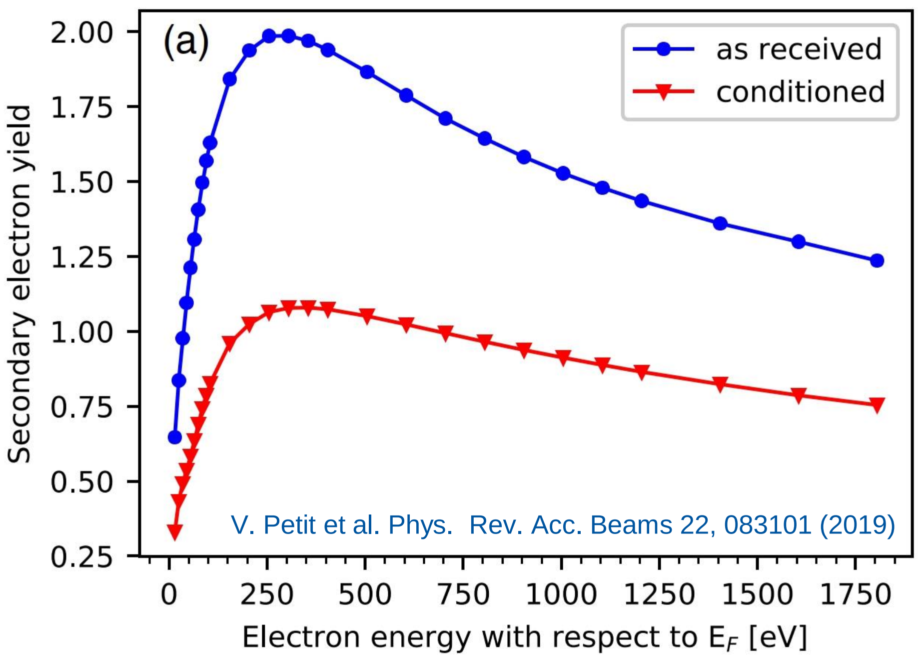
- Laboratory solutions for a-C coatings and CuLESS for E-cloud mitigation have proven efficiency

- Some technical constraints require rethinking of the development strategy

→ Definition and agreement of target thresholds for initial SEY maximum and required conditioning dose is required

Lab-based analysis of electron-conditioning

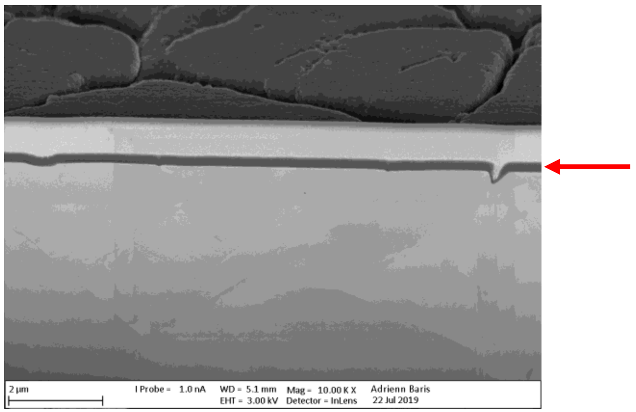


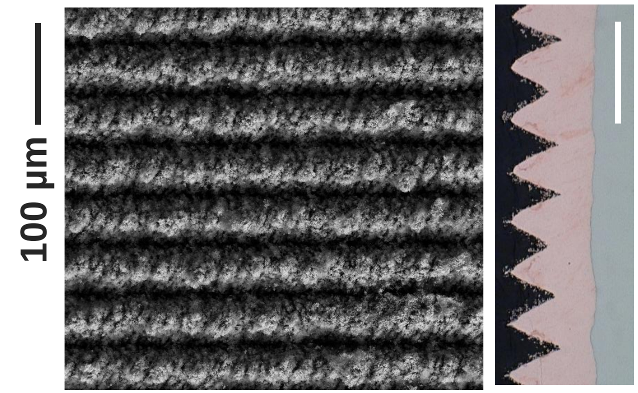


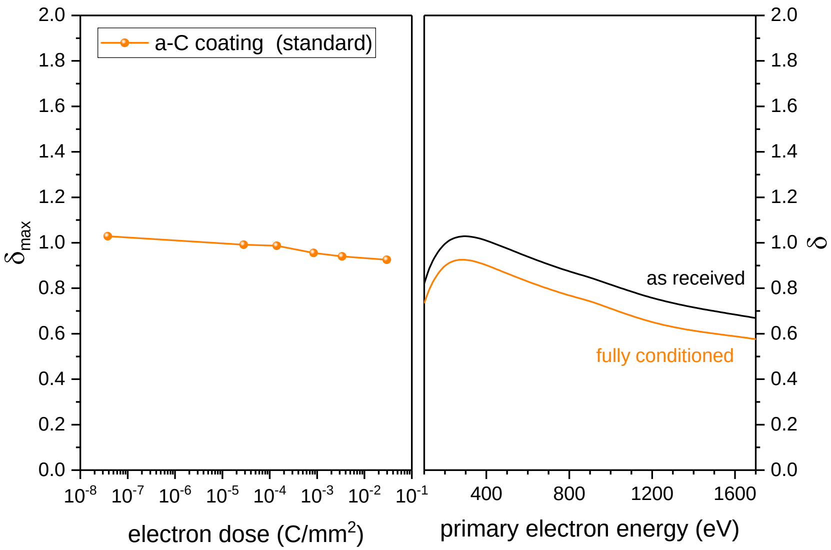
- Analysis of SEY changes vs. Electron dose at room temperature as input parameters for E-cloud and conditioning in the machine
- Real conditioning dynamics depend on SE generation, magnetic field and geometric aspects and have to be simulated

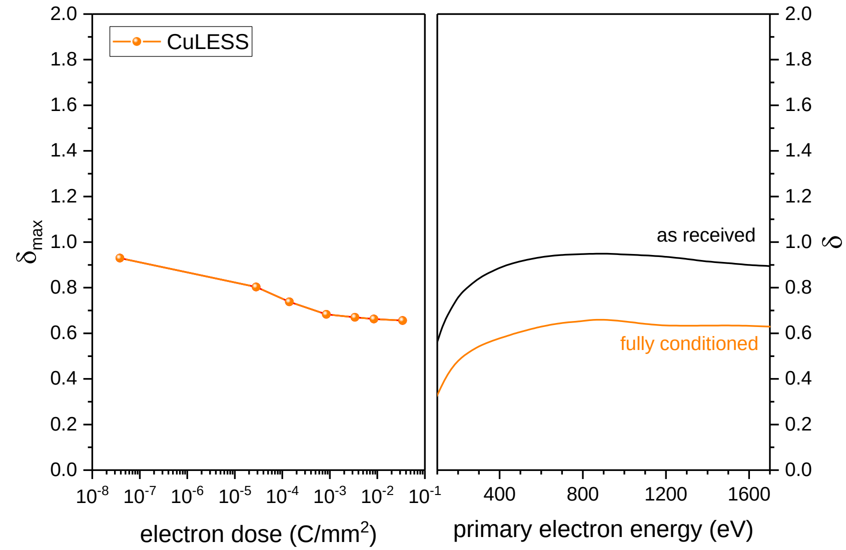
Two approaches for e-cloud mitigation

a-C film coating

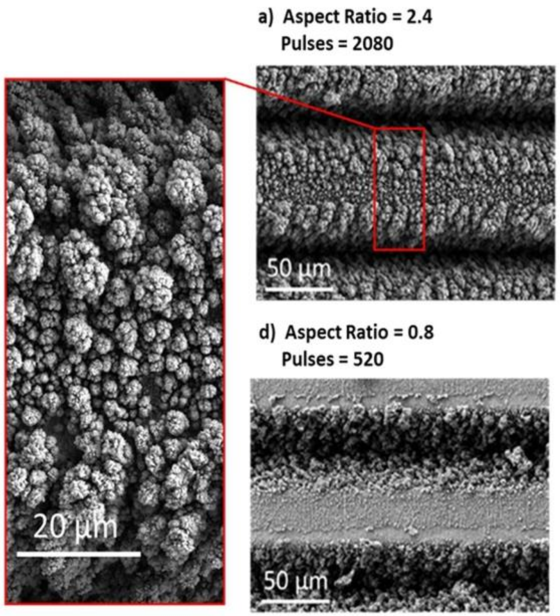






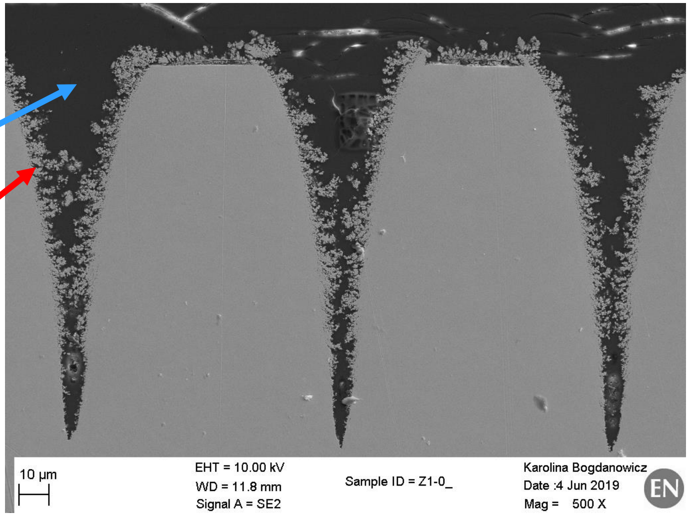


LESS – nanoparticles at the surface



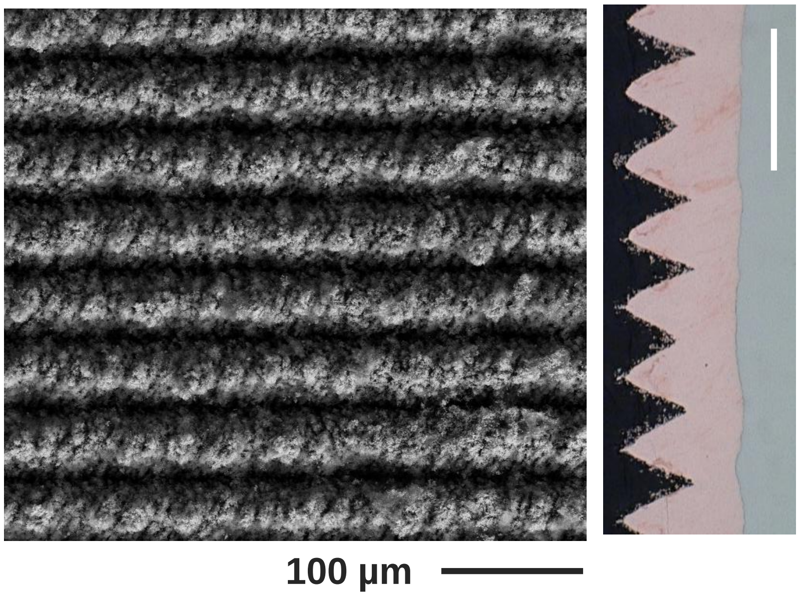
ablated region

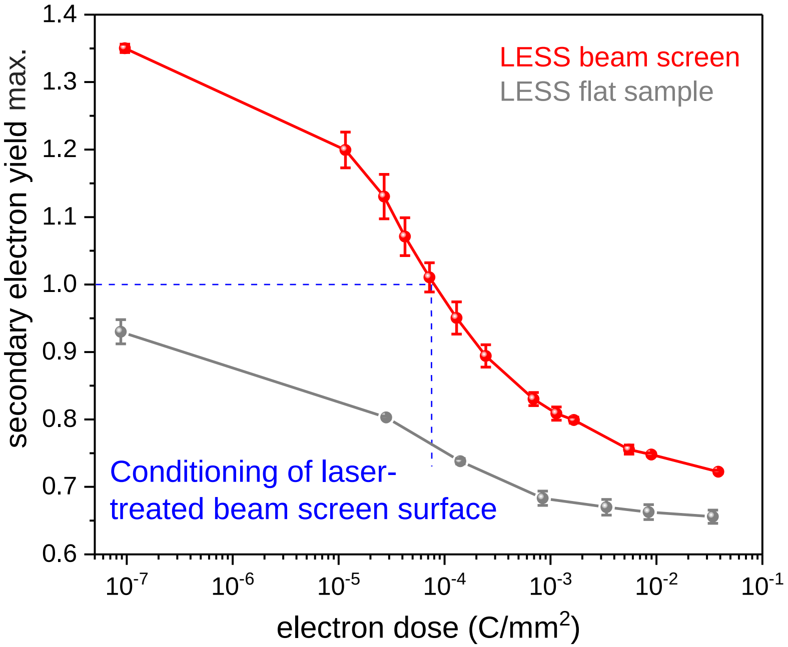
redeposited dendritic surface layer



- ➢ Surface patterning and redeposited nanoparticles define the SEY
- ➢ Ablation depth, trench distance and SEY can be tuned via laser parameter adjustment
- ➢ Surface is fragile and scratching, contact (i.e. RF Ball) should be avoided
- ➢ Risk of particle release during a quench are currently evaluated

LESS beam screen characteristics



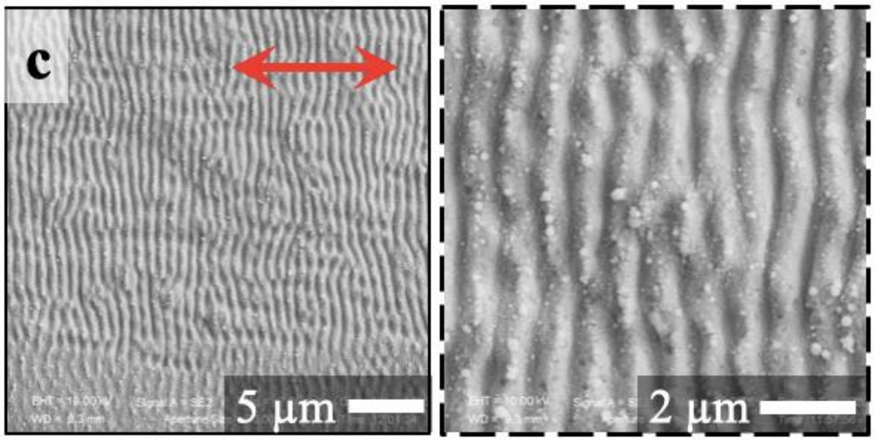


- Ablation depth too high (< 25 µm)
- Reduction of groove depth beneficial for surface Impedance

- SEY higher compared to lab LESS samples
- surface conditions to SEY<1 for electron doses $<10^{-4}$ C/mm^2

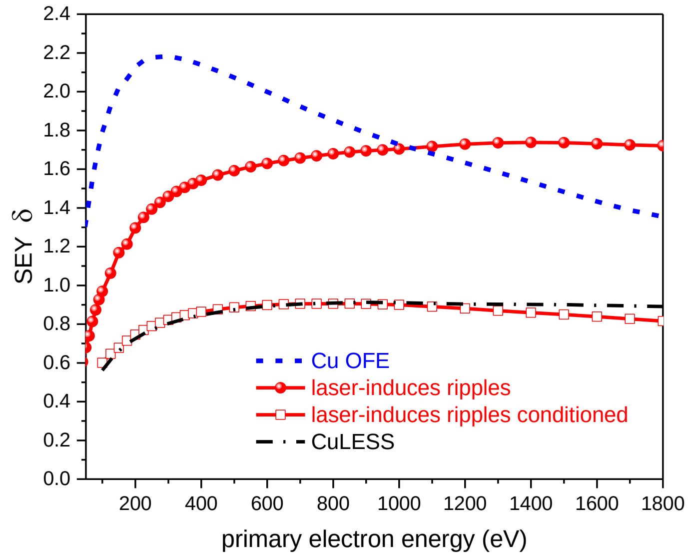
For machine-acceptance, the laser treatment has to be developed further.

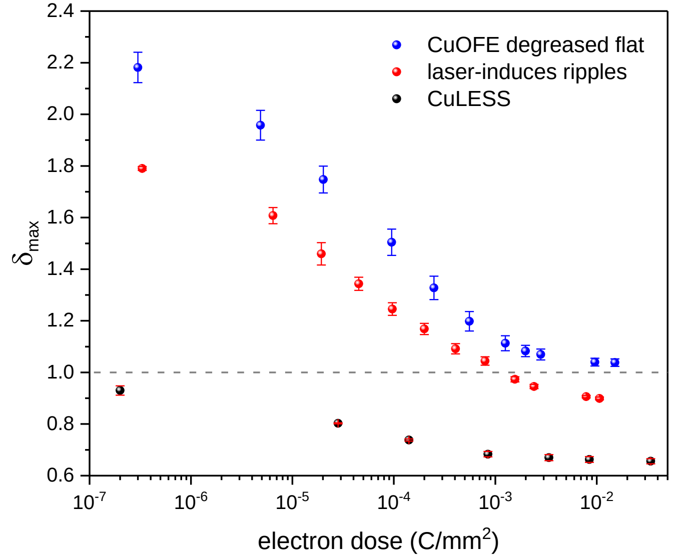
Low-Particle-density laser structuring



Courtesy of J. JJ Nivas (Univ. Naples), submitted to Appl. Surf. Sci.

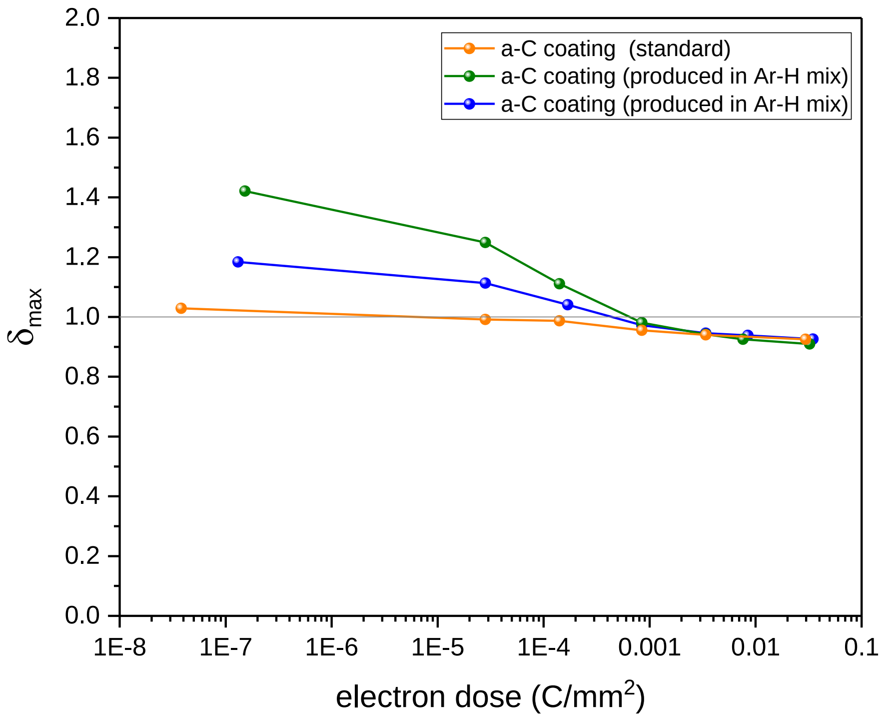
- Low-power treatment reduces particle coverage and ablation/undulation depth
  → Better for machine acceptance in terms of impedance aspects and risk of UFOs
- SEY maximum is in this case higher and can be tuned up to Cu OFE characteristics



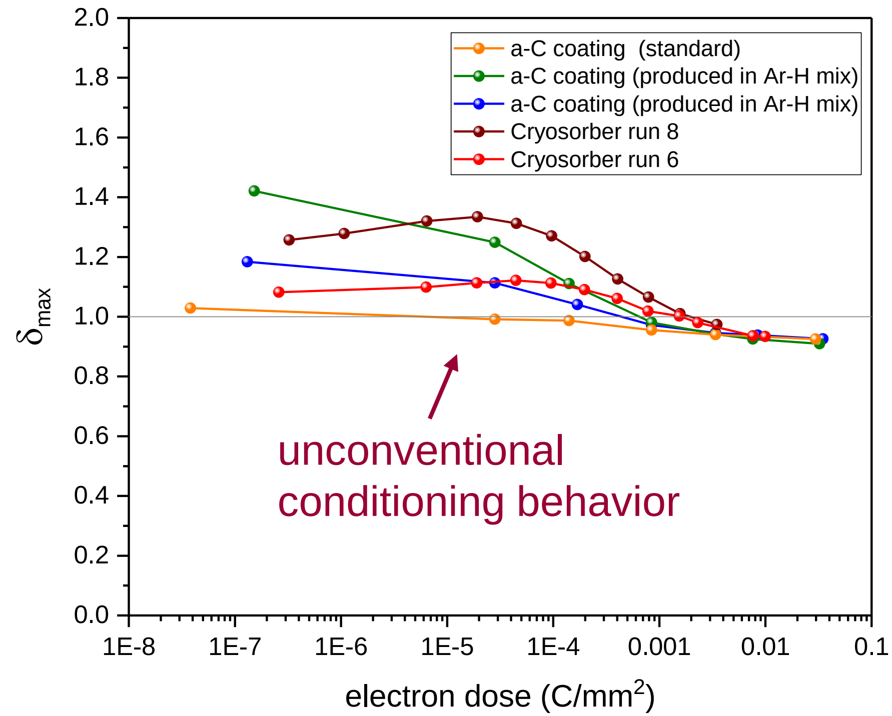


a-C coating with residual H_2

- Unintentional outgassing of hydrogen during deposition or intentional H_2 injection leads to an increased SEY maximum
- Coating setups, especially for magnets, do not always allow bakeout of the system prior film deposition
- If only hydrogen is incorporated, conditioning requires a reasonable amount of electron dose



a-C coating with H_2 and Cryosorbers



- ➢ Warm-up of cryosorbers induced desorption of species that affect the coating (not only H_2, also hydrocarbons) → R&D ongoing to mitigate the effect.

Discussion

Optimization of laser treatment for lower particle generation and low trench depth
+
a-C coatings in the presence of Cryosorbers

→ Initial SEY maximum of the surface will be > 1
→ Conditioning at reasonable doses will enable SEY < 1

The future development strategies requires consensus on parameters and conditioning benchmarks

<u>Proposal:</u>
✓ initial SEY maximum of the processes surfaces ≤ 1.5
✓ Conditioning allows to reduce SEY max. to < 1 for a dose ≤ 5×10^{-4} C/mm^2

The higher the values, the more flexibility for the treatment.

CERN