# R&D roadmap on surface functionalization

# Possible topics - Surface functionalization

- Surface secondary electron emission – mitigation of multipacting

- Engineering surface (Q, low fields, high fields)/ thin films / Electropolishing/ thermal treatments
  - Oxides
  - Within a few lambda

- Thin films on Copper (Nb, Nb3Sn…):
  - Protecting the surface after EP – stability
  - Cutting thermal currents
  - Kaptiza?

- What techniques? (thin film deposition, gaz, thermal treatments)

- Synergy with other deposition techniques

- For bulk and thin films

# Multipacting - Secondary electron yields

- Very thin films : < 10 nm.
- What materials ? (nitrides, carbides, carbon).
- What thickness ?
- Electrical conductivity matters (depends on Q).
- Demonstrated on 1.3 GHz -> needs a (bit) statistics…
- Applied to other geometries and materials (Cu): other cavities, long tubes
- Thin film deposition temperature compatible with the object (450°C), what is ideal?
- Techniques: sputtering, ALD…?

# Surface functionalization – Oxides

- Qubits -> increasing Q (coherence time) at low fields

  Deposition- passivation.

  Thinnest as possible.

  What material? (oxide, nitrides, carbides).

  Control the oxide growth on bare materials ( Nb, Ta) through thermal treatments under controlled atmosphere

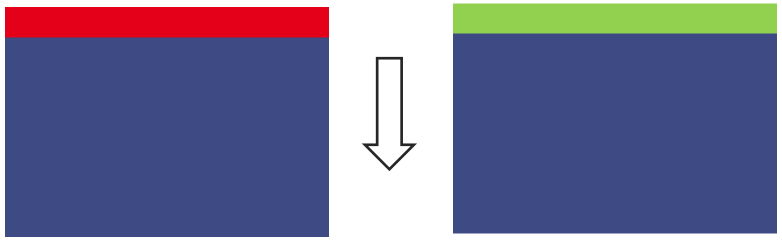
  Crystalline vs amorphous.

  Apply to Nb or other materials (Ta)?

# Surface functionalization – 2 λ (100 nm)

- Deposition method ? + thermal treatment
- On bulk Nb, thin films ?
- Surface passivation

- Medium field
  - Doping, what method?
  - Suppress post chemistry.



- High fields
  - Prevent hydrides formation / weaker surface superconductivity (critical currents).
  - Diffusion barriers on bulk/thin films for other deposition methods (multilayers)

# Surface functionalization on copper

- Protective surface layer
  - Stabilize the Cu surface ? (flexibility : ship cavities, time after EP to deposit)
- Cutting thermocurrents
  - Trapped flux -> reduce Q, increase Q-slope, and E max.
- Adaptating thermal stress with ceramics (A15, MgB2, HTs), tuning.
  - Delamination, stress induced degradation.
- Compatibility with other deposition techniques temperatures: (~ 150°C Nb ok but T up to 750C°C )
- No cross contamination with superconducting films.
- Damage of the layers by deposition techniques (ions)?
- What materials ?
- What thickness ?

# Notes

- Nb on Cu: 4.10^10 @ 20MV/m for ILC: 25 MV/m @ 2K, 310^9 @ 4.2K @ 10 MV/m.
- Nb3Sn on Cu: 4.10^10 @ 20MV/m @ 4.2K

- Nb3Sn not on bulk Nb…only pertinent if in a multilayer (other interface films) and Cryocooled (CANS) but limited to 6 MV/m.