ELECTRO ANNEALING-INDUCED MODIFICATIONS IN Nb SQUIDs

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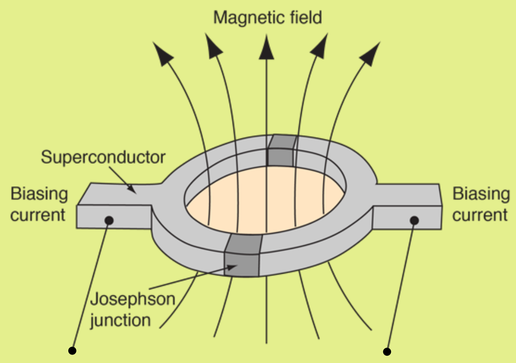
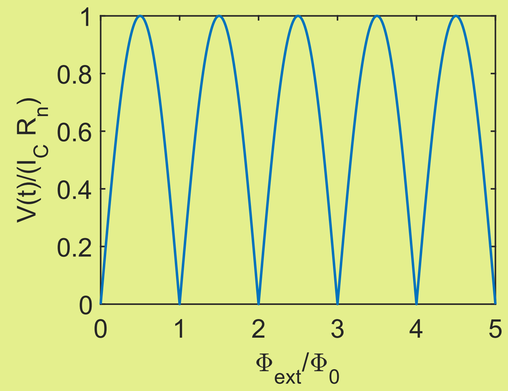
SQUID : Superconducting QUantum Interference Device

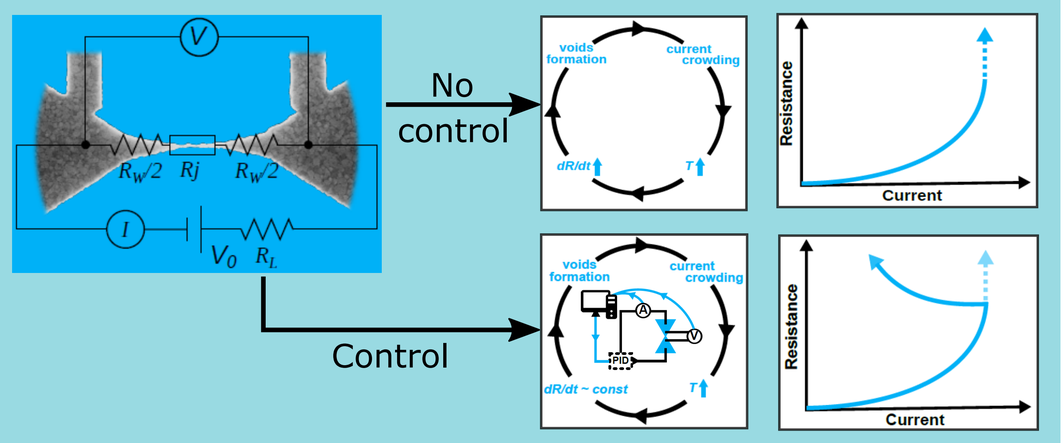




- SQUID is composed of two Josephson junctions in parallel forming a loop.
- Josephson junction (JJ) is formed by a weak link between two superconducting materials.
- Examples of weak link: an insulator, a metal, a superconductor of smaller T_C, a **Dayem bridge**.
- The weak link determines the properties of the JJ, and consequently, of the SQUID.
- SQUIDs are among the most sensitive magnetic field sensors.

Φ_0 = flux quantum = h/2e
= $2.068.10^{-15}$ Tm²

What is electromigration/electro-annealing?



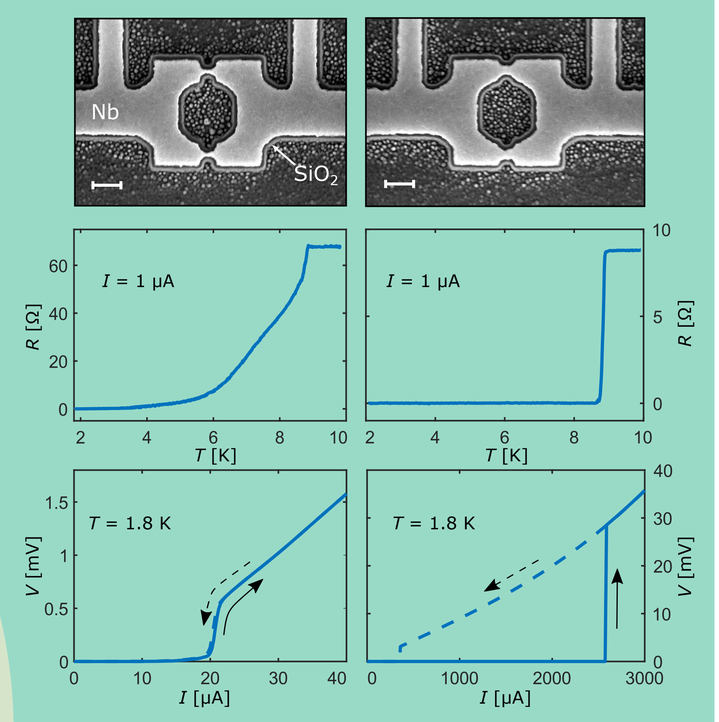
- Investigate the possibilities of EM/EA to go below the limit of conventional lithography (few tens of nm).
- Determine how EM/EA is able to tune the characteristics of a SQUIDs (oscillations, critical current, etc).

CONTEXT · EM · AIM · IMAGING · RESULTS

CONCLUSION

- Imaging methods confirm that the effect of EM/EA are located at the junctions of the SQUIDs.
- EM/EA process allows access to large interval for charateristic parameters of the SQUIDs

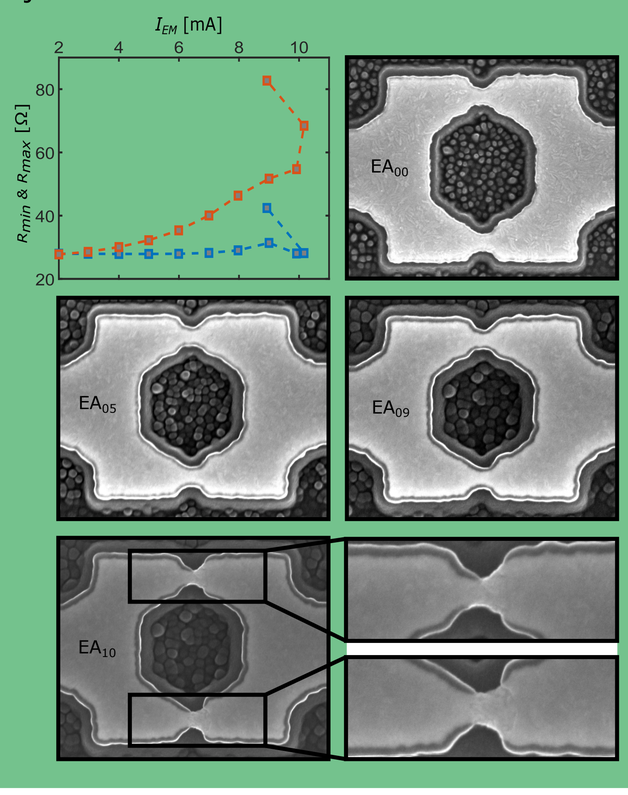
Virgin state : layout and V(I)

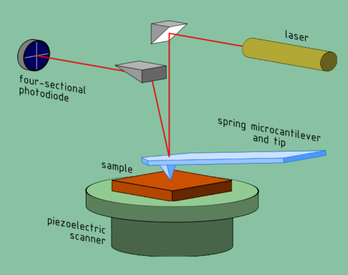


- Size of the Dayem bridge and etching process tremendously influence the critical current value.
- Bigger junction size allows larger critical current but irreversible V(I).
- Larger Dayem bridge favours the formation of a hot spot.

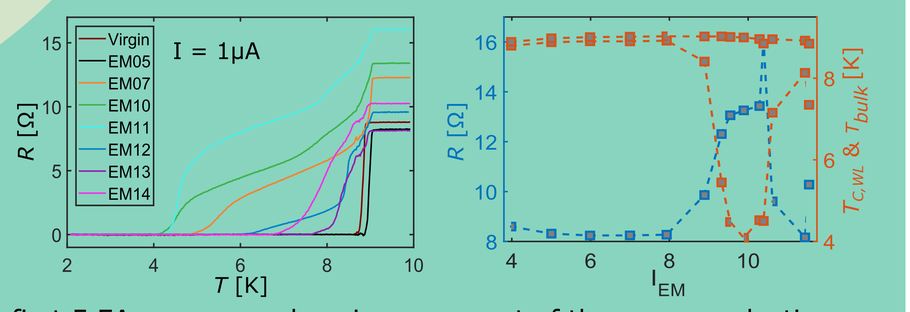
SEM imaging

- Ambient temperature, P ~ 10^{-6} mbar.
- Current crowding induces modification of the two junctions.





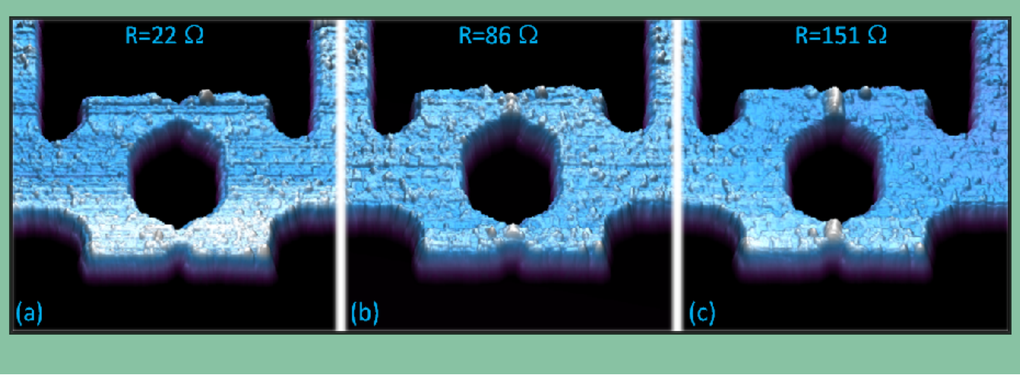
Progressive electro-annealing



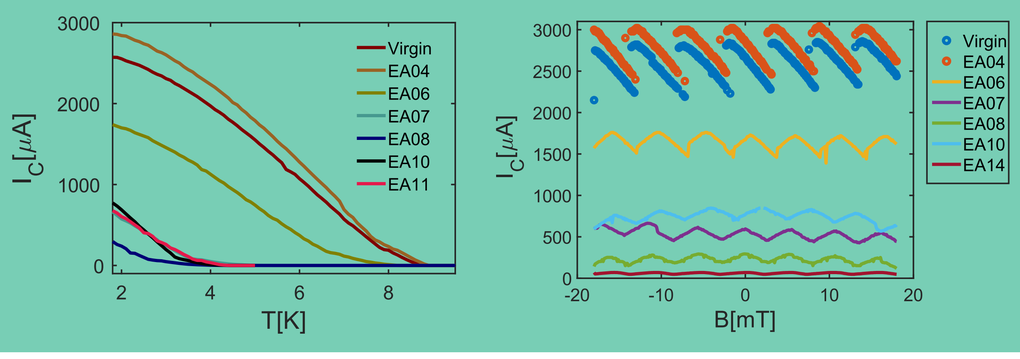
- The first 5 EA processes show improvement of the superconducting properties (lower normal resistance R_N and higher T_C).
- EA processes from 6 to 11, show a deterioration of the critical temperature and normal resistance.
- EA 12 and 13 show an unexpected and nearly total recovery of the original superconducting state (data to be confirmed).

AFM imaging

- Ambient temperature and pressure.
- EM create important atomic movements, creating hillocks at the junctions locations.



Critical current and SQUIDs oscillations



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