NitrAl: Nitridized aluminum thin films for superconducting qubit technologies

Authors: **Alba Torras-Coloma** (IFAE), Elia Bertoldo (IFAE), David López-Núñez (IFAE, BSC, Qilimanjaro), LeyreMartínez de Olcoz (CNM), Eva Céspedes (CNM), Sagar Paul (KIT), Wolfgang Wernsdorfer (KIT), Gemma Rius (CNM) and Pol Forn-Díaz (IFAE, Qilimanjaro)

Building quantum technologies with superconducting qubits puts stringent requirements on the choice of materials, as their quality and properties ultimately limit the circuit performance. In this work, we propose a novel superconducting material attractive for superconducting quantum circuits: nitridized aluminum (NitrAl) thin films fabricated by DC-magnetron sputtering in nitrogen-argon flows. At room temperature, the samples behave as a normal conductor (low N_2 partial pressures), and as an insulator (high N_2 partial pressures), finding the limit between both regimes in the samples processed with 13.33% - 15% N_2.

Measurements at low temperature show that the thin films display superconductivity for 0% - 13.33% N_2. Critical temperatures vary non-monotonically from hundreds of mK for the most resistive samples up to more than 3K for samples fabricated with 5% N_2. Similarly, critical field measurements point towards higher resilience to magnetic fields than bare aluminum, especially for samples in the range 5% - 10% N_2. We also report an important decrease in the critical current density for the most resistive samples and qualitative differences of the resistance behavior as a function temperature.

We assess the quality of the material and its suitability for superconducting quantum applications via resonator measurements. The preliminary set of data obtained indicate that internal quality factors of NitrAl resonators are at least on the same order of magnitude as the ones obtained on resonators produced on aluminum thin films. These results suggest that NitrAl may be used in a variety of applications in quantum circuits, ranging from a superinductor in the highly resistive regime to a larger-gap material in the low resistance regime.