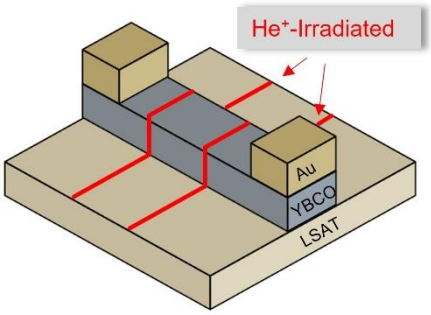
Bachelor-/Master Thesis Available!

Experimental Investigation of Josephson Junction Arrays

During the last decades many approaches have been pursued to realize a compact and tunable THz source based on Josephson junctions (JJs). As the emitted power of a single junction lies in the range of nW or even only pW, a source with sufficient output power requires the realization of arrays of Josephson junctions (JJ array). In this case, the junctions have to be coupled in such a way that via synchronization the emission of coherent radiation is achieved. In the past, the low-temperature superconductor Nb has been used to realize such arrays in various configurations [1]. However, due to the relatively small energy gap in Nb of approx. 1.3 meV, emission in a frequency range > 1 THz is not possible. Hence, large interest exists in the realization of Josephson arrays based on a high-temperature superconductor with significantly larger energy gap.

Since a few years our group has been working on the realization of JJs in thin films from the high-temperature superconductor $YBa_2Cu_3O_7$ (YBCO) by using He^+ irradiation. Here, a focused helium ion beam is scanned across a YBCO microbridge (see figure). Along the scanned line, the YBCO film changes its electric properties and a Josephson barrier is created. This method offers a very flexible and fast way for realizing YBCO Josephson junctions [2][3].



The goal of this Bachelor-//Master Thesis is to develop a better understanding of the properties of YBCO JJ arrays via measurements of their electric transport properties at low temperatures. For an understanding of the fundamental coupling properties between the junctions, this work will focus on simple arrays based on two JJs only. Arrays will be produced with different processing parameters, characterized and analyzed.

Depending on the time available (Bachelor- or Master-Thesis) the work will include the following activities:

- Preparation of samples (photolithography and Ar ion beam milling) for He^+ irradiation and characterization
- Characterization of the samples in liquid helium with the tunnelling electronics (slightly more advanced setup as in the JKO experiment of the F-Praktikum)
- Generation or extension of evaluation scripts in Matlab or Python
- Presentation and discussion of experimental results
- Design of new components for the measurement setup in CAD

[1] M. Darula *et al.*, Supercond. Sci. Technol. **12**, R1 (1999); https://iopscience.iop.org/article/10.1088/0953-2048/12/1/001
[2] B. Müller *et al.*, Phys. Rev. Applied **11**, 044082 (2019); https://doi.org/10.1103/PhysRevApplied.11.044082
[3] J. C. LeFebvre *et al.*, J. Appl. Phys. **131**, 163902 (2022); https://doi.org/10.1063/5.0087611

For further information: see www.physik.uni-tuebingen.de/fkp
or ask R. Kleiner: kleiner@uni-tuebingen.de phone: 29-7 6315, room D6 P40
D. Kölle: koelle@uni-tuebingen.de phone: 29-7 6324, room D6 P34
C. Schmid (PhD student): christoph.schmid@uni-tuebingen.de phone: 29-7 8616, room D6 A44

September 2022