

Technical Memorandum

Ambature TM # 2020-03

To: Ron Kelly, CEO, Ambature Inc.
Cc: Davis Hartman, Michael Lebby
From: Mitchell Robson
Date: 03/27/2020

Re: Importance of Smooth Layers

Ron,

When creating a trilayer tunnel junction, it is important to have the smoothest possible interfaces between the layers. Smooth layers help ensure that the insulating PBCO is a uniform thickness. Rough interfaces generally lead to a non-uniform PBCO thickness. Variation in thickness across the layer reduces the overall device performance as well as its reproducibility.

In our trilayer junction we rely on tunnelling to allow electrical current to pass through the thin insulating layer from one superconducting layer to the next. Tunneling is a quantum mechanics effect that says current can pass through non-conducting material if it is thin enough. If the three layers are high-quality and lattice matched, tunneling current is limited by the thickness of the insulating material. As thickness of the PBCO layer increases, the amount of current that can pass through decreases. If the layers are smooth, the thickness will be uniform and current can tunnel through the barrier uniformly. If the layers are rough, the thickness will likely vary across the junction, causing the current to be non-uniform.

Fig. 1 shows smooth and rough trilayer junctions. In the smooth junction, current can flow evenly across the whole interface. The amount of current flowing through is simply limited by the designed thickness and dimensions of the insulating layer. In the rough junction, some regions of the insulating layer are thinner than others. Current prefers to flow through the thinnest regions instead of across the whole junction, effectively reducing the total amount of current that can flow through. Roughness also creates reproducibility issues since it is random by nature and it can destroy devices by introducing short circuits.

Mitchell Robson

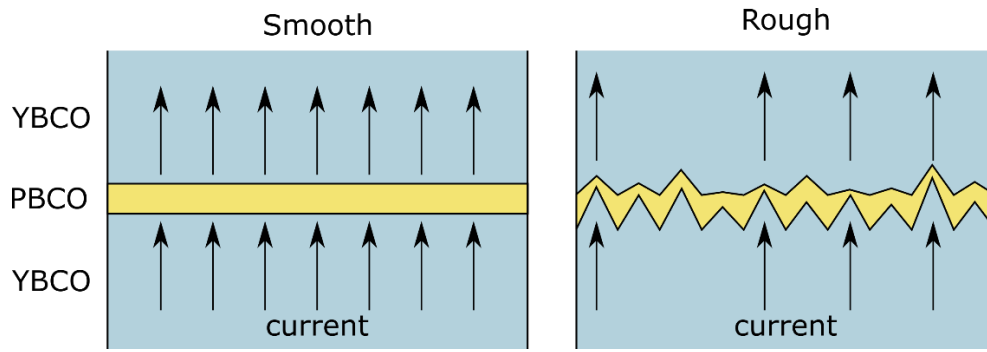


Fig. 1. Smooth vs rough trilayer junctions