Electrical conductivity measurements of films.

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The characterization of the electrical conductivity of films is mandatory in all materials but particularly in thermoelectricity, its measurement is crucial in order to be able to determine the power factor and the figure of merit. A technique that could be used to carry out electrical measurements on thin films is the four probe technique. However, the spreading of the current due to the electrical field or the influence of the electrical contact resistances complicate the determination and analysis of the electrical conductivity of the film.
In order to overcome these problems, we carried out a mesa attack on Bi2Te3 films grown by electrodeposition technique, which are hold on a Si substrate with a platinum layer of 150nm. The goal is fabricating pillars whose later film resistivity analysis could approach to the 1D electrical model, which cannot be taken into account when dealing with a big film area. For that purpose, a lithography process was done on films with different thicknesses, which consist of a pattern of disks with different diameters ranging between 120µm and 60µm diameter. After the lithography, we evaporated 100nm of gold on top of the disks that would act as the top electrode. Then, we removed the photoresist and we performed a mesa attack with diluted nitric acid (1:2.5). As a result, we obtained pillars as the ones showed in Figure 1. On these pillars, I-V curves with the four probe technique were taken and the resistances of the pillars were determined. Representing the resistance of the pillars versus the inverse of the area of the pillar, the total resistivity of the films, which includes the contact resistances between the electrodes and the pillar, is obtained. Finally, to determine the electrical contact resistance and obtain the pure electrical resistivity of the film, these measurements were performed on different pillar thicknesses.
The experimental results have been double-checked with COMSOL simulations of the four probe experiments carried out here.

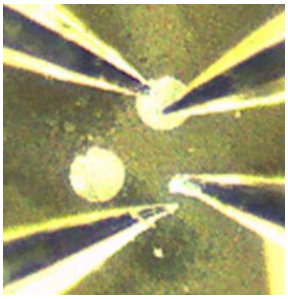

Figure 1: Topographic and Thermal images of organic P3HT Nanowires with different diameters.