Impact of the substrate transfer on the efficiency of GaAs solar cells

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The goal of hybrid photovoltaic-thermoelectric systems (PVTEG) is to utilize the Seebeck effect to convert heat produced in the cell into electricity [2]. However, these systems are still far from their optimal efficiency [3]. The difference between theoretical and measured power output can be partly attributed to a high temperature difference between the hot point of the TEG and the cell temperature. The drop of the PV cell efficiency with the temperature increase is thus not compensated by the small increase in temperature at the hot point of the TEG [1]. In order to reduce these losses, we propose a system where the TEG's hot point temperature is the closest to the PV cell as possible by transferring the cell on a copper substrate.

Fabricating and transferring an epitaxially grown PV cell onto a copper substrate requires important modifications to the standard PV cell fabrication process. These modifications involve the bonding of the cell onto the copper substrate at 450°C, thus creating internal constrains that cause defects in the crystalline structure as shown in figure 1. By chemically etching the copper substrate right after the thermocompression, we successfully relaxed the constrains. Figure 2 shows the GaAs wafer thermally bonded on the copper substrate before etching (A) and after a wet etch step where we successfully stopped on a 20nm thin $Al_{0.4}Ga_{0.6}As$ layer (B). Using this process, we expect to fabricate and characterize over cm^2 thin film GaAs solar cells on a copper substrate for integration in a PVTEG device.

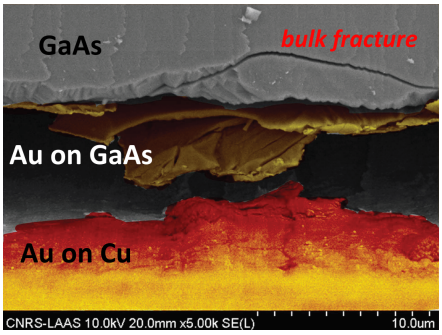

Figure 1: SEM observation colorized of cut GaAs after Au-Au wafer bonding highlighting multiple fractures in the wafer and at the bonding interface

Furthermore, we will present the fabrication and characterization under illumination and thermal stress of as-grown solar cells. By comparing the electrical properties of transferred and as grown solar cells at different temperatures, we expect to determine the impact of the new fabrication process.

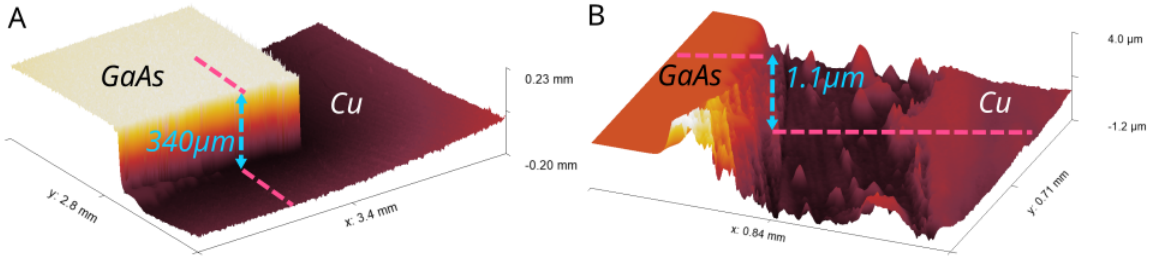

Figure 2: 3D profile of optical profilometer measurement of: (A) GaAs test substrate after bonding on a copper substrate and (B) GaAs substrate thinned via chemical etching stopped on a 20nm thin $Al_{0.4}Ga_{0.6}As$ etchstop

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