INVESTIGATION OF THE ELECTRICAL PROPERTIES OF METAL/PYRITE (FeS$_2$) JUNCTIONS

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Abstract

The nontoxic semiconductor pyrite FeS$_2$ appeals to us as a good candidate for solar cells because it has a small bandgap (0.05 eV) and is made from inexpensive materials. The electrical properties of the variety of metals (Au, Ni, Cr, Fe, Al, Fe) deposited on pyrite (FeS$_2$) were investigated for future application in pyrite photovoltaic technology. The first set of data collected, Cr, Al, and Fe pyrite junctions exhibit rectifying behavior that were Schottky barriers. The electrostatic potential barrier of the Schottky barrier depletion region creates an internal electric field which separates electron hole pairs by light. Au and Ni pyrite junctions have linear non-rectifying current-voltage (I-V) characteristics (ohmic). Our next step was to test Fe, Cr, and Fe junctions with a layer of indium (In) pressed upon the surface to serve as an Ohmic contact. Fe showed ideal characteristics of a Schottky barrier; however, the small barrier height and large series resistance did not facilitate the determination of an accurate barrier height at room temperature. Low temperature measurements will be carried out to see if more ideal Schottky barrier characteristics can be obtained; since the current transport through the depletion region of the Schottky barrier falls exponentially while series resistance falls much slower when the temperature is lowered.

Background Information

As one of the earth’s abundant materials, the small bandgap, nontoxic semiconductor (0.05 eV) pyrite FeS$_2$ appeals to us as a good candidate for solar cells. The integrated absorption coefficient for the spectrum of wavelength values between 300 and 750 nm is almost the same as the visible light range, making it ideal for photovoltaic application. Unlike silicon (Si), pyrite is easily obtainable at a very low cost (Wada et al 2009-2566). Out of 23 preceding semiconducting materials, twelve were found to meet or exceed the annual worldwide electricity consumption. Further elimination allowed only nine possible candidates for their potential for a significant cost reduction. Extraction cost was a factor and the unconventional solar cell candidates included FeS$_2$, Cu$_2$, and ZnS$_2$ (Wada et al 2009-2702). For high volume production of solar panels, cheaper material for commercial use will be a huge factor to drive research advancement.

Procedures

In previous studies (Newman), the clean condition of the surface proved to be independent of the barrier height. However, to ensure all factors are well controlled, the samples will be cleaned and polished as best as possible for consistent results. There are five metals (Ni, Au, Cr, Fe, Al) to be investigated. The experiment procedures are as below:

- Polishing step must be executed thoroughly with the right processes. Using (in order) 240 grit, 400 grit, 800 micron, 9 micron, 6 micron, 3 micron, and 1 micron pads interchangeably (Fig.2), a shiny, flat surface is achieved with tedious examination.
- The deposited metals (Au, Ni, Cr, Fe, Al) were tested at room temperature to have only one metal in contact with the surface of the samples.
- I-V measurements will be taken from all the samples with evaporated metals.
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Discussion of Results

The deposited metals (Au, Ni, Cr, Fe, Al) were tested at room temperature to have only one metal in contact with the surface of the samples.

- Why are we interested in Schottky barriers? Schottky barriers are those diodes that produce a Schottky barrier at the semiconductor and metal interface. This can be explained through electron flow from the semiconductor to the metal. At lower temperatures, the diode is more Schottky barriers. The deposited metals (Au, Ni, Cr, Fe, Al) were tested at room temperature to have only one metal in contact with the surface of the samples.

Future Research

The deposited metals (Au, Ni, Cr, Fe, Al) were tested at room temperature to have only one metal in contact with the surface of the samples. The results demonstrated that evidence of Schottky barriers could be found at room temperature.

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