

A. Title Page

X-Ray Fluorescence of Thin Films
Final Report

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B. Restatement of problem researched or creative activity

Photovoltaics involves the direct conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. When these free electrons are captured, an electric current results that can be used as electricity.

Figure 1 illustrates the operation of a basic photovoltaic cell, also called a solar cell. Solar cells are made of the same kinds of semiconductor materials, such as silicon, used in the microelectronics industry. For

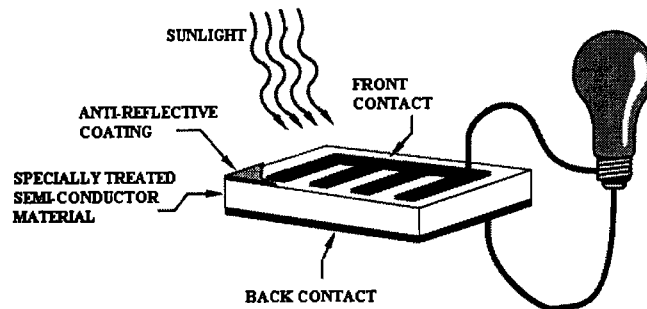


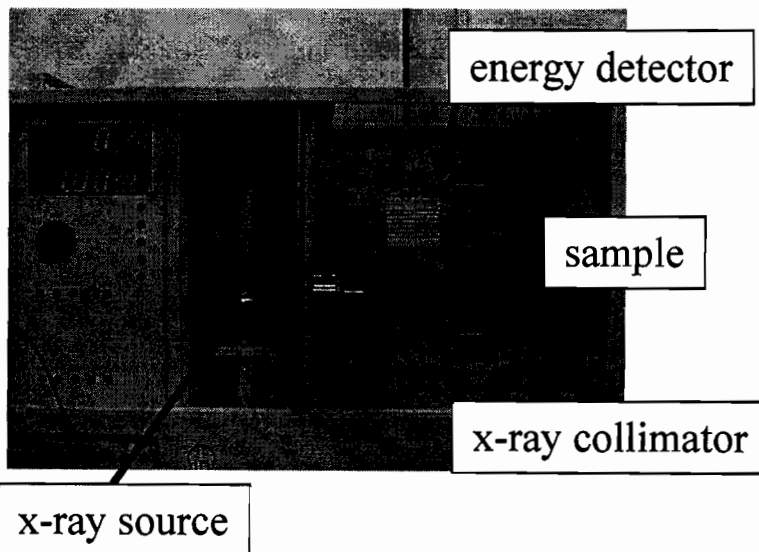
Figure 1 Diagram of Solar Cell

solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material. If electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form of an electric current -- that is, electricity. This electricity can then be used to power a load, such as a light or a tool.

Today's most common PV devices use a single junction, or interface, to create an electric field within a semiconductor such as a PV cell. In a single-junction PV cell, only photons whose energy is equal to or greater than the band gap of the cell material can free an electron for an electric circuit. In other words, the photovoltaic response of single-junction cells is limited to the portion of the sun's spectrum whose energy is above the band gap of the absorbing material, and lower-energy photons are not used.

One way to get around this limitation is to use two (or more) different cells, with more than one band gap and more than one junction, to generate a voltage. These are referred to as "multijunction" cells (also called "cascade" or "tandem" cells). Multijunction devices achieve a higher total conversion efficiency because they can convert more of the energy spectrum of light to electricity. The efficiency of these multijunction PV cells is directly related to the thickness and composition at the junctions of the different cells. Impurity atoms or defects at these junctions will significantly decrease the number of photons converted to electrons thereby inhibiting the electrical power output. Understanding the surface physics involved in the production of these junctions will lead to more efficient PV cells.

C. Brief review of the research procedure utilized



A major portion of this project was the purchase, installation and testing of the X-Ray Fluorescence apparatus. Figure 2 shows a picture of the setup.

The fluorescence device consist of a source of

Figure 2 Picture of the X-ray Fluorescence setup collimated x-rays, that have been generated by a Molybdenum x-ray tube aimed at a sample. This radiation knocks inner electrons from the atoms, resulting is a cascading effect from the electrons in higher energy levels. These electrons emit radiation in order to jump to the vacant energy levels.

The energy detector scans a wide range of energy levels. The data, shown in figure 3, can help us determine not only which elements are present in a sample but the relative concentrations of the atoms.

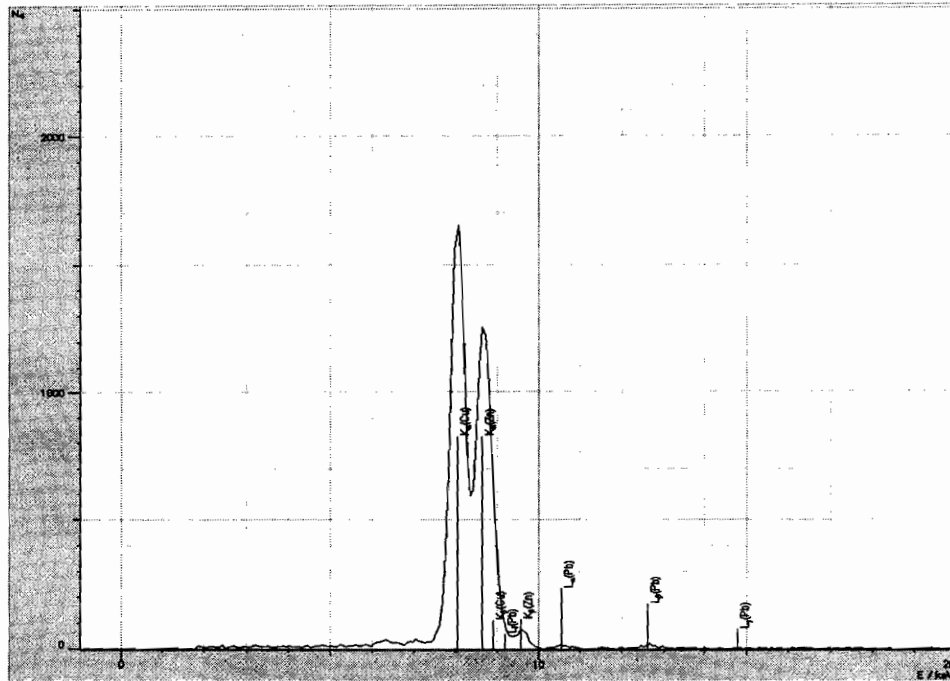


Figure 3 X-Ray Fluorescence data of Cu (58%) - Zn (39%) - Pb (3%) alloy. The x-axis show the energy detected and the y-axis is the intensity of the radiation

D. Summary of findings

In summary we have successfully installed and calibrated our x-ray energy detector. This new technique will allow us to measure the thickness of thin films used in photovoltaic cells.

E. Conclusions and recommendations

In conclusion this device will be used for our nanoscience research. Also we will use it in the Advanced Physics Lab course, Introduction to Nanoscience course, and the Physical Chemistry course.