Molybdenum (Mo) back contact thin film layers for thin film CuIn$_x$Ga$_{(1-x)}$Se$_2$ (CIGS) solar cell were deposited onto the soda lime glass substrate using direct current (DC) planar magnetron sputtering deposition technique. It is well known that the properties such as mechanical, morphological, optical, and electrical properties of the Mo thin film are dependent on the sputtering process parameters such as working gas pressure and discharge power of the process plasma.

The requirements for the Mo back contact layer are various. Sheet resistance, contact resistance to CIGS absorber, optical reflectance, surface roughness, and adhesion to glass substrate are the properties that Mo back contact thin film layer must satisfy. The key is how to achieve satisfying Mo thin film by adjusting the discharge power and gas pressure. Generally, Mo thin films deposited at higher discharge power and lower gas pressure tend to be less resistive since the films have well crystallized larger grains and dense microstructure; however, such films exhibit poor adhesion to the glass substrate due to their residual compressive stress. On the other hand, films deposited at lower power and higher pressure tend to have higher resistivity due to the poorly crystallized smaller grains and porous microstructure, whereas the films exhibit excellent adhesion due to their residual tensile stress. Therefore, it has been a practice to deposit multi-layered Mo back contact to achieve the properties of both good adhesion to the glass substrate and low resistivity simultaneously. However, using the multi-layer Mo back contact layer is not desirable from the industrial point of view due to its low throughput and high process time and cost.

As can be seen, the above mentioned process parameters and the corresponding Mo thin film properties are at the two extreme ends of the spectrum. Hence experiments were conducted to optimize the discharge power and gas pressure that will produce single layer Mo thin films that exhibit adequate properties of both adhesion and sheet resistance for solar cells simultaneously.

Efforts were made to develop a single layer Mo back contact thin film. Various combinations of discharge power and gas pressure were experimented. Scotch-tape test was carried out on each film to determine the adhesional strength of the films to the substrate. The sheet resistance, resistivity, and average roughness for each film were measured using a four point probe measurement setup and Dektak Profilometer. Hardness measurement was carried out using triboindenter and the stress analysis was carried out using bend test of very thin glass strips.

The relationships between the processing parameters and above mentioned properties were studied in order to develop a single layer Mo back contact layer for CIGS thin film solar cell. It was found that by selecting the processing parameter properly, low resistive and high adhesive Mo thin film can be achieved.

Major: Materials Science and Engineering

Educational Career:
Bachelor's of Engineering, BS, 2000, Tohoku University
Master's of Engineering, MS, 2002, Tohoku University

Committee in Charge:
Dr. Neelkanth G. Dhere, Chair, Materials Science and Engineering
Kar Aravinda, Optics, MMAE, ECE and Physics
Helge Heinrich, Physics and Materials Science and Engineering

Approved for distribution by Dr. Neelkanth G. Dhere, Committee Chair, on March 18, 2010.

The public is welcome to attend.