CIGS Thin Film Solar Cells And Target Materials

December 2007

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Introduction

Billions of dollars being invested in the alternative energy market, investors seem like they are throwing money at nearly any startup with a half decent idea and a capable management team to back them up. Investment in CIGS based solar cell manufacturers is no exception. The solar market is forecasted to be huge, so huge that it seems ludicrous to quote the total forecasted growth opportunity. Suffice it to say that if a plant is in production with proven solar cells at market price, they will not have much difficulty finding customers for the next 15 years. I can understand why investment in this area continues to pick up, the benefit to using a CIGS process is that it has the potential to dramatically reduce the cost of manufacturing and with high product yield. The cost of all solar cell production is dependant on the cost of the raw materials needed for production. The latest Silicon shortage is driving material costs up for Silicon based solar cells, compounded by the ever increasing demand for Silicon in semiconductor industries, is providing no help in lowering the cost to produce silicon based solar cells. According to a May 2007 article by the Copper Development Association in New York:

> "*…the cost of CIGS modules has steadily decreased and is now reportedly lower than polycrystalline silicon, the most common solar cell semiconductor*".

The silicon shortage is providing an additional incentive for investment in alternative solar cell technologies. For CIGS thin film solar cell manufacturing, process control starts with the material: the target. If process starts with inadequate material, process will yield inadequate results, this is dogma for process engineers. For those developing CIGS based solar cells (and all others in thin film), usable quality material is on the top of the list. As with all thin film companies, they must balance target quality and cost to find the most advantageous combination. The total cost and quality of material will make or break CIGS cell manufacturers.

Background

There are a number of companies developing CIGS solar cells in three categorical approaches so far: using thin film targets, evaporation, and nano particles. To date, CIGS solar cell production has only made it from the lab to the production floor with evaporation. Each process strategy has limitations in part governed by the material form factor. For example, material for evaporation is easy to obtain and use, however, it's a process that can be inefficient in material usage, slow to coat substraights and difficult to control. Materials such as Gallium and Indium can be expensive (and difficult) to powderize into nano form, or at least into a usable form for thin film particle placement in correct stoichiometry. Physical Vapor Deposition is fast, and perhaps ideal for CIGS cell production, however, usable target materials have proven elusive in the past. High density CIG targets have the potential to enable faster development and deployment of production CIGS cell lines. How PVD CIGS cell manufacturers develop their processes will be the greatest area of technical differentiation and in large determine CIGS cell efficiency.

The Competitive Edge

Material quality and utilization will become increasingly more important as the market progresses. As more players jump into solar cell production to meet increasing demand for solar cells, the efficient use of material will become one of the most important production differentiations a company will compete with. One comparison to illustrate the competitive edge that target material creates is the location business axiom (the first three rules) to the criticality of material for thin film solar cells. The modified axiom should read the first three rules of thin film solar cell business are material, material, material. Unlike the business location axiom these days where the most desirable location must strike a balance between where intellectual property is safest and the lowest skilled labor rates. I suspect determining a strategic location would be different for each company. Similar to legal and labor issues in our location example, both quality and economy play critical roles in determining the best material format for the job. Target quality will constitute film consistency and baseline cell efficiency. Economy of target materials will determine a significant portion of the bottom line and profitability. How a company best utilizes quality material will likely be a significant factor in determining market leaders.

The Benefit of Casted CIG

After years of research and development, casted CIG targets are now available. With casted CIG targets, processes are being defined and the effective use of material will be one of the most important cost differentiating points a CIGS cell manufacturer will have. Determining the optimal economic cost model for quality materials is vital for producing competitively priced solar cells. The optimal use of material must include cost effective reclaim of spent targets. Casted targets enable a high level of total material utilization, because of the increased density, target life and control are extended as well as be reclaimed and reused to make new CIG targets. There is a significant difference between powder metallurgy targets and casted CIGS targets; casted target processes can reuse the spent material, literally machining clean material off spent targets and loading it into a furnace to make new targets. Powder metallurgy may employ a number of fabrication techniques such as cold spray, pressing, which may or may not include sintering. For powder based CIG targets, the spent material must be reclaimed to make new CIGS powder for the fabrication process. Powderizing very soft metals such as Indium and Gallium can be difficult and prone to introducing contamination depending on the methodology. Then the powder must be sifted into the proper size, another point of potential contamination. Those particle sizes that are not the right size are sent back for remelt and re-powderized. These additional steps add cost to material, unlike melting the spent target material for casting. Both casting and powder based targets have a fabrication cost, however, casting has the advantage of reusing spent target material more cost effectively.

New Material Model

The best economic model for acquiring material involves the option for the CIGS cell manufacturer to purchase the raw materials at the best possible price from primary producers. This model will work for CIG target casting services; however, it may not work with powder

metallurgy as the pre-processing of raw materials in usable form may be proprietary. The cost of material in casting CIG targets does not require the pre-processing of raw material (Cu, In, Ga). In this model, the manufacturer can bypass middleman markup and send the raw material to the casting company directly. In our 3 years of research and development in CIG target casting technology, once casted targets are spent, roughly 95% to 98% of the material is reclaimed (depending on the tube condition). Casting process material loss is generally less than 3%. In this model, sputtering with casted CIG material should yield upwards of 90% total material utilization when you consider the ability to remove CIG from spent targets and cast it again. In this model the investment in raw material should yield 90% real total usage of material in the chamber. With a 70% material utilization on rotatable and 25% on planar, spent targets can be reclaimed and recast to make a new target. In this way a company that invests $100,000 in raw material (Cu, In, Ga) for casting targets can get $90,000+ of that material directly in process. The only difference is an additional casting fee on spent material. In other terms, every 4th to 5th target can be made from reclaimed material.

Conclusion

This model of casting services and target consumption enables both the casting service company and CIGS cell manufacturer to focus on their core competency and maximize economics of material use.

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