



## CASE STUDY

# VACUUM SYSTEMS FOR THE SOLAR INDUSTRY

## 1<sup>ST</sup> GENERATION CELL (CRYSTALLINE SILICON)

Producing Poly silicon Solar grade silicon is produced in the reactors using metallurgical grade silicon by means of chemical vapor deposition (CVD) process. The process introduces silane gas with high temperature polysilicon rods inside a cooled bell jar. The silicon contained in the gas will deposit on the heated rods, which gradually grow until the desired diameter has been reached. The usage of a vacuum system is to evacuate the reactors prior to a chemical reaction taking place. Vacuum operating level for this application is anywhere from 0.5 to 1 Torr. Kinney® can supply either booster/piston systems, booster/vane systems or booster/dry pumping systems.

## MULTICRYSTALLINE



## MONOCRYSTALLINE

## GROWING MONOCRYSTALLINE

Once solar grade silicon is produced in the CVD reactors, it is then melted in the crystal growing furnace. The final product is called "Monocrystalline silicon ingot" has a round shape.

## CASTING MULTICRYSTALLINE

Polysilicon chunks placed into the Die-cast Furnace (Directional Solidification System) to produce "Multicrystalline silicon ingot" have a square shape. Our Booster/Air Ejector/Liquid Ring System with a max vacuum capacity of less than .1 Torr and Two Stage Rotary Piston pumps with a max vacuum capacity of .0002 Torr and full pumping speed below .1 Torr. Our pumps have been running for years in the production of monocrystalline and multicrystalline ingots. This process requires vacuum systems that work reliably in dusty environments as vacuum pumps will see silicon monoxide particles. The Operating vacuum is anywhere from 0.03 to 18 Torr, and some applications even higher. We can also supply dry running screw pumps for this application.

## CUTTING INGOTS INTO WAFERS

Once the ingots are produced, it goes to the wire saw machine. It is cut it into wafers by taut wire that runs through abrasive slurry (silicon carbide and glycol), which acts as the cutting agent between the work piece and wire. From an economic point of view this slurry is recycled and conditioned to gain 75% to 90% in pure form. Our single and two stage liquid ring vacuum pumps are used on slurry purification systems. The operating vacuum is anywhere from 75 to 100 Torr.

## 2<sup>ND</sup> GENERATION CELL (THIN FILM)

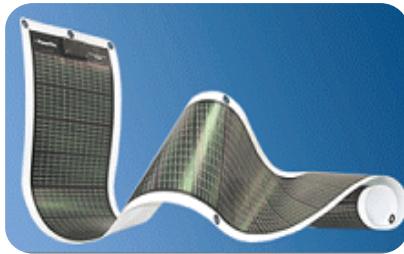
Many thin-film devices are based on amorphous silicon alloys. Other thin-film devices are usually poly-crystalline materials. The fabrication of a thin-film solar cell involves depositing a layer of semiconductor material (such as amorphous silicon, copper indium gallium diselenide, or cadmium telluride) on a low-cost substrate, such as glass, metal, or plastic. Current deposition techniques can be broadly classified into physical vapor deposition (PVD), chemical vapor deposition (CVD), plasma enhanced chemical vapor deposition (PECVD) or some combination of them.

Vacuum pumps will see toxic, corrosive, explosive, pyrophoric and light gases such as hydrogen, Silane, helium, sulfur hexafluoride (SF<sub>6</sub>), Nitrogen trifluoride (NF<sub>3</sub>), phosphine, Germane, Boron Trifluoride and many more depending on process and technology. In addition, vacuum pumping speeds and rapid chamber cycling are essential. Our two stage vacuum systems meet the above requirement. Our systems equipped with NEMA control panel to operate on/off the system as well as safety interlocks for the system such as high oil temperature and high gas discharge temperature. Inert gas purge controls also provided to suit the application.

## ENCAPSULATION OF PHOTOVOLTAIC CELLS

Both 1st generation and 2nd generation photovoltaic cells are assembled and laminated using EVA (Ethyl Vinyl Acetate) encapsulant. It helps to hold together the top surface of PV cells and rear surface of the PV module. Kinney can supply either rotary vane or dry screw vacuum pumps for this application. Typical vacuum requirement is < 2 Torr.

### 2<sup>nd</sup> Generation Production



A-Si Thin Film



CIGS - Module



CdTe — Thin Film