

PV-Series Thermal Deposition Sources for Thin Film CIGS

Leading R&D. Enabling production.



Powering solar production.

High Volume Manufacturing of CIGS

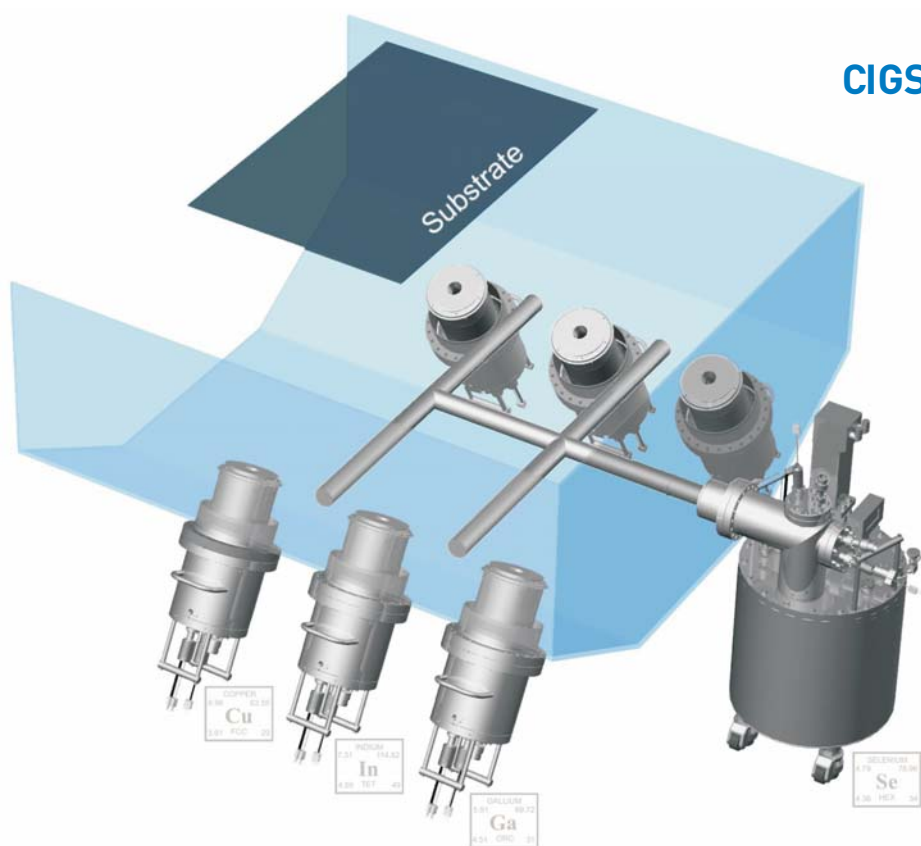
Thin film solar cells have attracted considerable interest within the solar industry due to the increased efficiency in manufacturing (<\$1/watt). For CIGS thin film manufacturers, one of the most demanding challenges is transitioning CIGS processes from R&D to high-volume manufacturing.

The challenge is in providing high capacity, high reliability and high deposition rate thermal deposition sources for copper, indium, gallium and selenium. Deposition sources must be reliable and deliver stable flux over time in capacities sufficient for a week or more of uptime. These performance parameters are particularly important in order to achieve low manufacturing costs.

Veeco provides this solution in our production-capacity PV-Series™ Thermal Deposition Sources for CIGS, capable of depositing across 120cm-wide substrates while achieving $\pm 5\%$ thickness uniformity—providing the highest performance technologies presently on the market. For over 20 years, Veeco has excelled at designing and manufacturing material-specific thermal deposition sources for both R&D and production thin film deposition systems. Our focus has been on providing reliable sources with high material utilization while ensuring the highest level of performance.

Veeco thermal deposition sources demonstrate excellent thickness uniformity and stability in some of the most demanding electrical and optical applications. Veeco sources have become the production standard because of their large capacities, high temperature operation and long term stability—all critical factors in the CIGS deposition process.

Veeco's PV-Series Thermal Deposition Sources, incorporating patented design elements, are an ideal choice for R&D and high-volume manufacturing of CIGS solar cells—enabling you to meet your goals for R&D systems to high volume manufacturing.



Anatomy of a CIGS Deposition System

Pictured is a typical CIGS deposition module incorporating Veeco PV-Series Thermal Deposition Sources. The module is shown optimally configured with six SUMO® sources for copper, indium and gallium and one valved source for selenium, providing high material utilization (50%) with excellent thickness non-uniformity ($\pm 5\%$) on 120cm-wide substrates.

Our PV-Series SUMO Sources and Valved Sources are available in production capacities, allowing for a week or more of continuous operation.

Veeco's thermal deposition sources, incorporating patented design elements, enable the manufacture of CIGS solar cells at the lowest cost while ensuring the highest performance.

PV-Series Thermal Deposition Sources

Production-Scale SUMO Sources for Copper, Indium and Gallium



PV-Series 1500cc Source with SUMO Crucible.

Features

- 1500cc crucible capacity and high temperature operation
- Dual filament heater
- Patented SUMO crucible design
- Modular design

Benefits

- Enables long production uptimes and Cu deposition rates up to 20g/hr
- Prevents material accumulation at crucible opening, reducing defects
- Enables production capacities while minimizing long-term depletion effects
- Enables in-field service and maintenance

Production-Scale Valved Source for Selenium



PV-Series 15,000cc Valved Source.

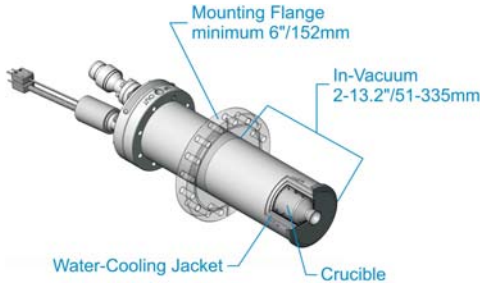
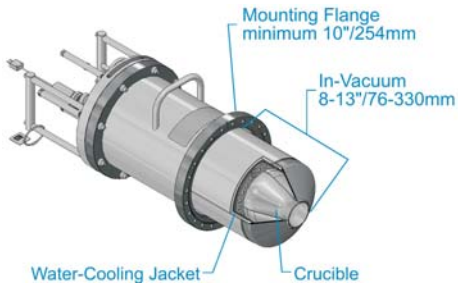
Features


- 15,000cc crucible capacity
- Linear nozzle design
- All-metal valve

Benefits

- Extends uptime, minimizing material loading cycles and system vents
- Maximizes material utilization while providing uniform material distribution
- Enables near instantaneous flux adjustment and on/off control

Product Specifications

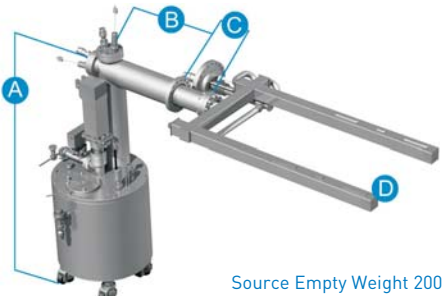
| Source Characteristics | PV-Series SUMO Source for Cu, In, and Ga | | |
|-------------------------------|--|---|--|
| | Research | | Production |
| |  | |  |
| Model | Source PV-65-SUMO Crucible PV-65-CC | Source PV-155-SUMO Crucible PV-155-CC | Source PV-1500-SUMO Crucible PV-1500-CC |
| Nominal Crucible Volume | 65cc | 155cc | 1500cc |
| Empty Weight | 16.6lbs/7.5Kg | 16.9lbs/7.7Kg | 80lbs/36Kg |
| Typical Operation Temperature | 900-1500°C | | |
| Maximum Power Consumption | Base 1000W @ 1500°C Tip 1000W @ 1500°C | Base 1000W @ 1500°C Tip 1000W @ 1500°C | Base 22A/5000W @ 1400°C ¹ Tip 28A/5000W @ 1500°C ¹ |
| Heater Type | Dual heater filaments, independently controllable | | Dual heating zones consist of pyrolytic graphite on PBN, slaved control |
| Maximum Base Zone Ramp Rate | 20°C/min to 400°C 50°C/min above 400°C | | 10°C/min to 400°C 50°C/min above 400°C |
| Thermocouple Type | Two Type C (W/Re 5/26%) | | One Type C (W/Re 5/26%) |
| Water-Cooling | Standard | | |
| Flow Rate | 2 l/min minimum | | 2 l/min minimum |
| Power Supplies | Two Veeco DC Power Modules are recommended. SCR supplies NOT recommended | | Two 5000W DC Power Modules with PID control or four Veeco 2500W DC Power Modules are recommended. SCR supplies NOT recommended |

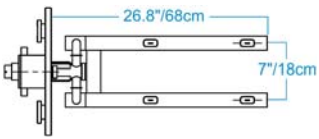
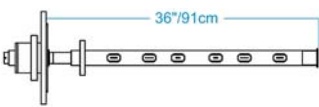
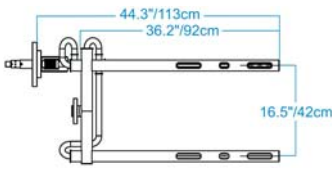
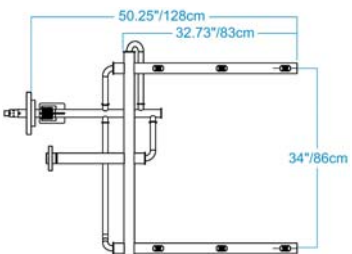
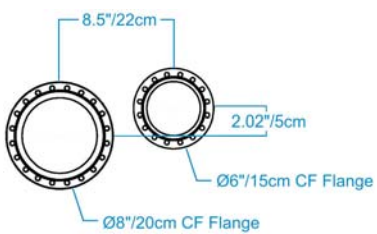
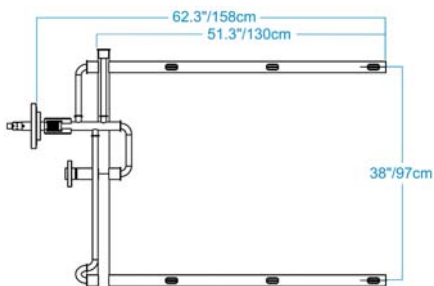
| Source Characteristics | PV-Series Valved Source for Se | |
|--------------------------------------|---|--|
| Model | PV-15000V-Se | |
| Nominal Crucible Volume | 15,000cc | |
| Empty Weight | 200lbs/91Kg (not including nozzle) | |
| Typical Operation Temperatures | Crucible zone 250-350°C Valve zone 300-400°C Conductance zone 450-550°C Nozzle zone 400-500°C | |
| Maximum Power Consumption | Crucible zone 18A/1500W Valve zone 12A/1000W est. Conductance zone 2A/200W Nozzle zone varies depending on nozzle configuration | |
| Heater Type | Two wire filaments, one cartridge-type heater | |
| Thermocouple Type | Four Type K | |
| Water-Cooling | Standard for body and lid | |
| Flow Rate | 2 l/min minimum | |
| Power Supplies | Three Veeco DC Power Modules are recommended, one additional if utilizing a Veeco nozzle | |
| Valve Driver Communication Interface | Analog or digital Modbus RS485 | |
| |  | |

* Other flange types and sizes are available, contact Veeco.

¹ Actual temperature. Thermocouple temperature reads lower.

NOTE REGARDING PV-SERIES VALVED SOURCE FOR SELENIUM—The standard configuration for this source is outlined below and can accommodate a variety of nozzles for different substrate sizes as shown. For other available configurations or custom size nozzles, please contact Veeco.

| Source Characteristics | | 15,000cc PV-Series Valved Source for Se Standard Configuration** | |
|------------------------|--------------|--|--|
| Model | PV-15000V-Se |  <p>Source Empty Weight 200lbs/91kgs</p> | |
| Source Height (A) | 31.12"/79cm | | |
| Horizontal Length (B) | 14.7"/37cm | | |
| In-Vacuum Length (C) | 6.48"/17cm | | |

| | | Nozzle Configuration | Substrate Width | Chamber Flange Size |
|----------------------|--|----------------------|---|---------------------|
| Nozzle Options** (D) |  | 13.78"/35cm | 12"/31cm or larger | |
| |  | 23.62"/60cm | | |
| |  | 14.57"/37cm | | |
| |  | 39.37"/100cm |  | |
| |  | 47.24"/120cm | | |

** Additional configurations are possible, please contact Veeco for more information.

Veeco: Your CIGS Equipment Solution Provider

Manufacturers are in search of equipment suppliers that can provide modular, user-configurable solutions that enable process goals to be met today and tomorrow. Look no further. With over 50 years of experience in thin film technology, we offer fully integrated solutions for CIGS.

Veeco is the industry's only thin film deposition equipment supplier that provides production-proven thermal sources integrated into a CIGS deposition system. Our solutions provide customers with high volume, low cost solutions that drive down the manufacturing cost per watt.

Our sources offer the largest capacity in the market, and in conjunction with our modular, multiple deposition zone system design deliver high process flexibility and high throughput. Each zone supports a full complement of copper, indium, gallium and selenium thermal sources.

Veeco's FastFlex™ Web Coaters and FastLine™ Glass Coaters can be configured in a variety of deposition layouts for optimal process conditions, maximizing material utilization and providing excellent thickness uniformity.

Veeco understands the value of forming strategic partnerships with our customers from our experience in similar industries. We have the capacity, the worldwide infrastructure and financial stability to meet the growth needs of the industry and our customers. Our global service and support ensures fastest time to market, we offer a full family of products with high throughput and low CoO, complete and integrated CIGS thermal deposition systems, and we have an aggressive roadmap to keep pace with industry cost goals. Let Veeco power your solar production.



The Veeco Advantage

- Industry-leading equipment supplier with more than 50 years of thin film expertise
- Metrology equipment for atomic level wafer surface analysis available
- Direct process support available from renowned Veeco applications laboratory
- More than 25 locations worldwide for local service, including on-call equipment maintenance engineers and spare parts depots
- Reliable, committed, financially stable partner

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Powering solar production.