The Ventana™ Optical Train

*LPI* announces the Ventana™ Optical Train, a complete off-the-shelf optics solution for the CPV module manufacturer and integrator. Module manufacturers using Ventana™ can eliminate the design costs, tooling costs, and long lead times required to obtain optics.

The optical train includes a Fresnel-Köhler™ (FK) primary optical element (POE) and a glass secondary optical element (SOE). Based on *LPI*’s patented FK architecture, Ventana™ provides the best combination of concentration, acceptance angle, efficiency, compactness and irradiance uniformity on the market.

The Ventana™ POE is produced in a roll-to-roll process that yields very sharp tooth and notch radii (<5μm). This contributes to the high efficiency of the system. Because of the low stresses induced by this *Evonik Industries* process, the POE has a 25-year project-specific warranty, among the best in the industry. The fiducial marks on the lens panel make module assembly a very easy process.

The FK architecture, along with its advanced 4-fold geometry, overcomes chromatic effects, yielding high performance levels within the entire acceptance angle cone. The SOE design eliminates cell-assembly meniscus losses, facilitates insulation of the cell from moisture, permits mechanical hold downs, and optical coupling using non-structural gels that appear to be less sensitive than adhesives to degradation from high UV concentration.
Measured Performance

The Ventana™ system with Evonik’s PMMA POE, a 39% 3MJ cell, and no AR coating on the SOE has demonstrated the results in the table to the right.

"Intelligent Optics Efficient Solutions"

The plots below show the irradiance distribution of the Ventana™ Optical Train at normal incidence for the top cell and middle cell wavelengths. The irradiance uniformity is extremely good even at the full acceptance angle and is independent of the spectrum and incident angle.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical Train Efficiency (POE+SOE)</td>
<td>&gt;83%</td>
</tr>
<tr>
<td>f #(diagonal aperture/height)</td>
<td>~1</td>
</tr>
<tr>
<td>Acceptance Angle*</td>
<td>+1.1°</td>
</tr>
<tr>
<td>POE Lens Size (mm²)</td>
<td>160 × 160</td>
</tr>
<tr>
<td>Cell Illuminated Area (mm²)</td>
<td>5 × 5</td>
</tr>
<tr>
<td>Geometrical Concentration</td>
<td>1024×</td>
</tr>
<tr>
<td>Module Efficiency**</td>
<td>&gt;32%</td>
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</tbody>
</table>

*Actual acceptance angle measured in the short circuit current as a function of incidence angle curve
**Measured outdoors with a 39% 3MJ cell, no AR coatings, and temperature corrected (25°C)

Forecasted Performance

LPI has wide experience with predicting array performance and expects that, with AR coating on the SOE and a higher performing cell, the system should achieve >86% optical efficiency and >34% (DC @ηcell=40%, 25°C) module efficiency. Because the optical characteristics of the Ventana™ Optical Train are perfectly matched to maximize the module efficiency, LPI expects this performance to be maintained to the array level with minimum drop, thanks to the large tolerances of the Ventana™ system.

Kits for prototyping Ventana™ optics will be available in June, 2012. Please contact LPI for information on production quantities, alternative POE materials, designs, and other support services.

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