FoCOUPLER™ Foconic Optical Couplers for LEDs.

It all starts at a chip…

Development of efficient high-brightness LED light sources involves fundamental studies of emission mechanisms in ZnS- and GaN-based wide-bandgap compound semiconductors. While internal quantum efficiency (i.e. electron to photon conversion)has been constantly improving external quantum efficiency continues to remain appallingly low, so that 50 – 90 % of a generated flux is trapped and absorbed inside a chip. Realization of illumination sources and fixtures for general market using LEDs calls for a significant improvement of EQE..

Visus Photonics achieved a significant progress in developing realistic practical designs based on the innovative concepts of LED chip design and EQE (or simply Extraction Efficiency) conserving optical architecture by considering both optimal chip shape (mesostructures) and encapsulant primary and secondary optics.

Unique Foconic volume and EQE conserving couplers are integrally formed with LED as its primary optics replacing a conventional encapsulator lenses. Focon is a complex compound elliptic-hyperbolic conical section with a minimal thickness approaching a theoretical limit. Special math apparatus based on Light Field Theory has been developed to generate these smooth surfaces by our optical SW KEREN ™.

1. **New foconic FoCOUPLER™ optocouplers ensure brighter LED with higher EQE with a thinner die structure meaning less expensive and more efficient chip and, not less important more compact and effective lamp size, e.g. more compact secondary optics;**
2. **Design of Dye configuration, Primary and secondary LED Encapsulant Optics are intimately intermingled to produce an optimal lamp package. With a coupler optics tailored to a given chip and particular application one can attain the most effective solution. Unfortunately, it is often not the case, as many chip makes do not fully realize all practical implications, which the latter has on an end product and prefer standard less effective encapsulation design, if any.**
3. **Foconic couplers have also a second major function: adaptation of an inherently lambertian intensity distribution of an LED to a particular application. Thus LED can turned into a side-emitting type allowing more uniform BLU.**

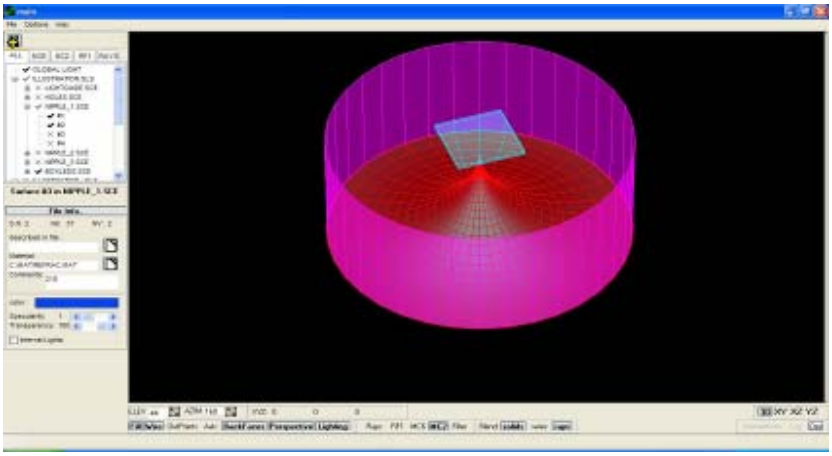

Figure 18. Foconic volume and EQE conserving CRATER™ coupler with an ejection aperture restricted by TIR angles. Optimal for LEDs coupled to large lightguides with extractors (BLU, large planar sources). Generated by our optical SW KEREN ™. Actual Scale.

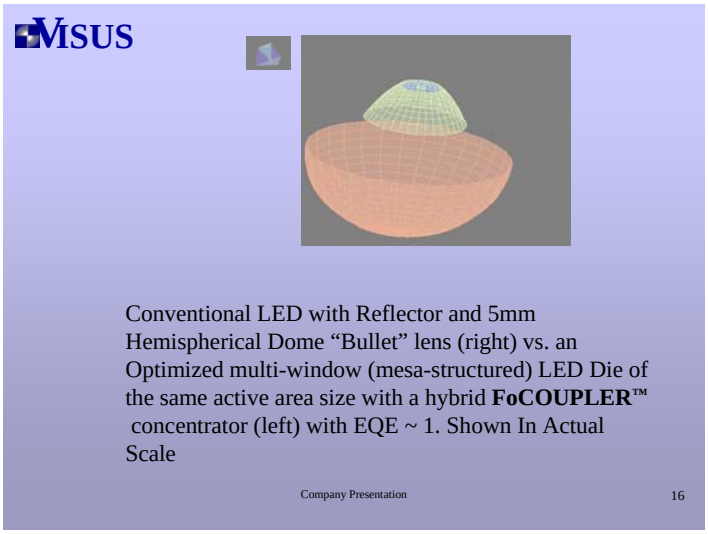

Figure 19

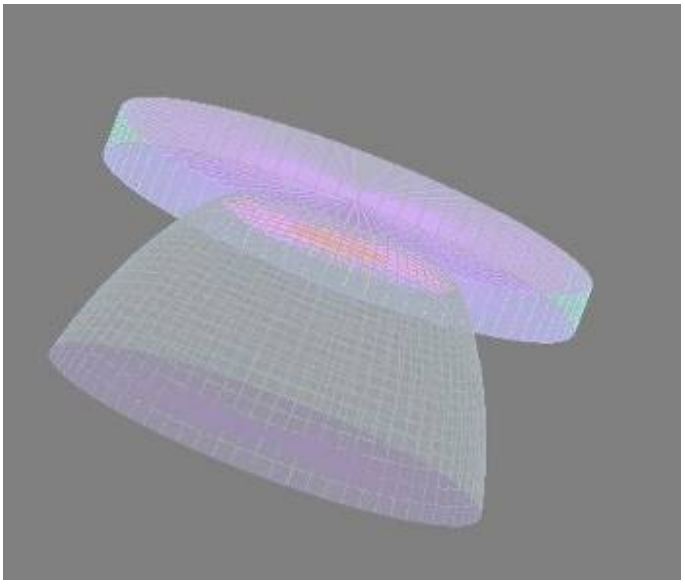

Figure 20. Example of CPC-like foconic microlens producing maximal flux collimation and EQE.

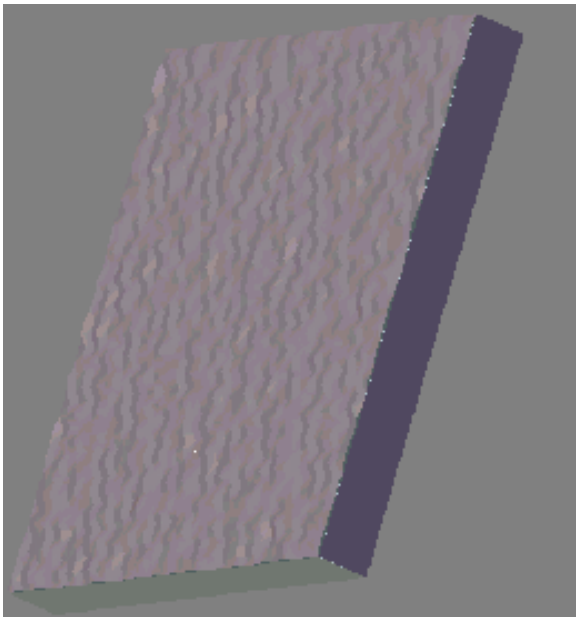

Figure 21. Controlled roughening of LED die improves EQE.