Qual Diamond Case Study
Hi-tech Corporation

# Featured Material – Zinc Selenide

Zinc selenide (ZnSe) belongs to the II-VI semiconductor compounds with one element from Group 12 and one element from Group 16 on the periodic table. With a large band gap of 2.7 eV, ZnSe has found its way into a wide variety of optoelectronic devices. These include blue light emitting diodes, blue laser diodes, photodiodes, thin film transistors, and even solar cells (1). ZnSe is very rare in nature. It can be grown in both cubic and hexagonal crystal structures (2).

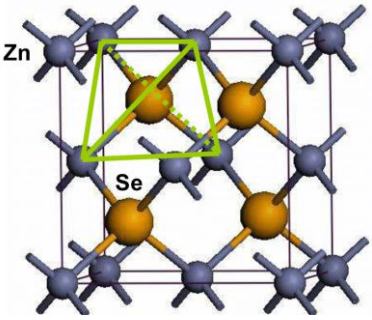



Fig. 1. Cubic ZnSe crystal structure (zincblende), credit N. Vivet

**Grinding and Polishing of ZnSe**

Low absorption of infrared light and high transmissibility of visible light make lenses of ZnSe highly desirable in optical applications. The large exciton binding energy, 21 meV, and electron transport properties also make ZnSe a good semiconductor material. The processing of lenses and semiconductor materials requires high precisions and tolerances. The grinding and polishing of brittle materials such as ZnSe are usually carried out in three steps: rough grinding, semi-finish polishing, and finish polishing. Each step has to undo the damages resulting from the previous step, while trying to achieve the prescribed specifications. Sometimes, the damages from previous step(s) are too great that the final finishing step cannot undo the defects and achieve specifications, resulting in yield losses.

There have been reports of using diamond turning from rough grinding to finish polishing ZnSe, with the final roughness (Ra) at 8 nm and the best at as low as 3.2 nm on aspherical surfaces (3, 4). We can take these two numbers and conclude that around 5 nm is the Ra achievable by diamond turning. However, diamond turning often times represent significant upfront investments on machines and customized tools, which need to be reworked or replaced regularly, and low throughput capability. In addition, the damages brought by fixed abrasives may be significant and cannot be easily undone.

**Qual Diamond Diamond Slurries for Grinding and Polishing ZnSe**

Here we present a 3-step lapping (loose abrasive polishing) procedure of polishing ZnSe down to 4 angstroms Ra using different diamond slurry and polishing pad for each step. For more details regarding the results, email sales@qualdiamond.com.

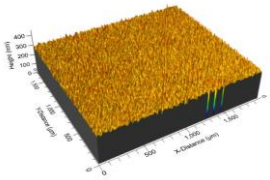
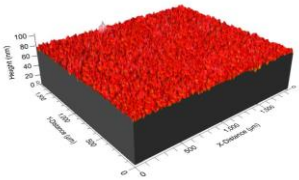
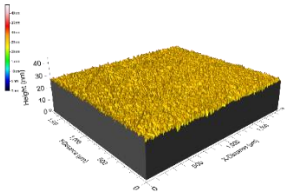
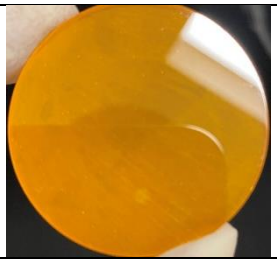
| Qual Diamond Slurry & | Hydroqual™ Coarse Grain (µm) Polycrystalline | Dynaqual™ Medium Grain (µm) Polycrystalline | Dynaqual™ Fine Grain (nm) Polycrystalline |
|---|---|---|---|
| **Polishing Pad** | **QDPD** | **QDTXD** | **QDMD** |
| **MRR (µm/hr)** | 85-100 | 23-30 | 1.6-2.0 |
| **Ra (nm)** | 7 | 1.3 | 0.40 |
| **Scratch/Dig** | N/A | N/A | 10/5 (0/0 Possible) |
| **Surface Roughness - White Light Interferometry** |  |  |  |
| **Substrate Before/After Images** |  |  |  |

Table 1. Results of 3-step ZnSe grinding and polishing procedure.

**References**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3. Ying Su, Xianhe Chen, Xiaogang Guo, Guo Rui, Xuanmin Liu, Feng Zhang, Chao Yang, Yingyu Xiao, Zengqi Xu, "New fabrication technology in single point diamond turning for IR aspheric optical parts," Proc. SPIE 9281, 7th International Symposium on Advanced Optical Manufacturing and Testing Technologies: Advanced Optical Manufacturing Technologies, 92811L (6 August 2014); doi: 10.1117/12.2069649
4. Bharti, R. K., Dhami, S.S. (2021). Optimization of Machining Parameters in Ultra-precision Diamond Turning of Zinc Selenide. *Journal of University of Shanghai for Science and Technology, 23*, 601-610.