

## CIROM<sup>TM</sup>-2 Zinc Sulfide Ultra-dense Polycrystalline Material For Optical Coating

### Optical Applications

Optical Zinc Sulfide films are transparent over the region between ~400 nm and 14  $\mu\text{m}$  and are typically used in combination with appropriate Fluoride (low-index) compounds to construct beamsplitter, bandpass filters, and other coatings. In the IR region at wavelengths longer than 2  $\mu\text{m}$ , it is the low-index component in combination with Ge, and is used in multi-layer designs. Most IR coatings designed for wavelengths above 6  $\mu\text{m}$  use ZnS, as opposed to high-index oxide compounds, because it is transparent and provides a large index-contrast with Germanium. Further, ZnS is easy to deposit, and exhibits low absorption and low mechanical stress, even in layers several  $\mu\text{m}$  thick. Combination with oxide layers is not recommended because of the potential risk of adhesion problems.

### Electro-Optical Applications

Dense films possess a high dielectric constant. When doped with appropriate impurities, Phosphors for electroluminescent displays can be made. Developments using these Phosphors as thick films are in progress for electro-optical switching applications. Zinc Sulfide films have been used to passivate and AR coat some semiconductors.

### Film Properties

The films grow with a characteristic columnar microstructure whose column size and void volume (comprising packing density) are dependent on the substrate tempera-

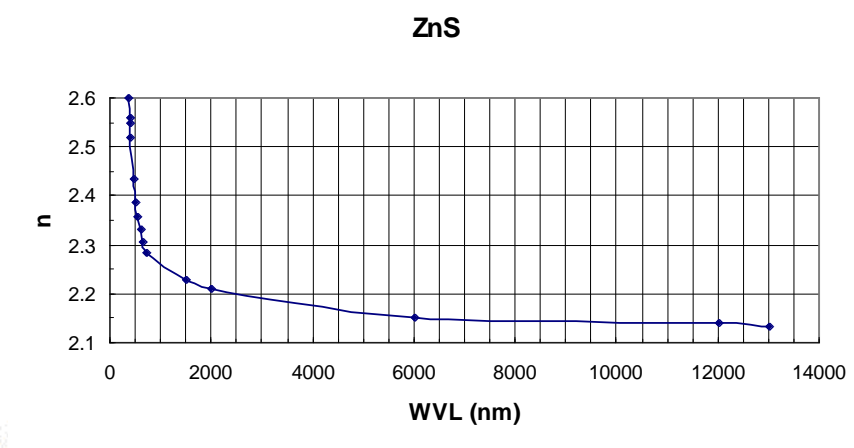
ture. Zinc Sulfide layers are relatively soft, insoluble in water, but slightly hygroscopic. Unlike Oxide films of similar low packing density, little shift in optical properties such as index is exhibited between humid and arid atmospheres. The introduction of charged particles such as bombarding electrons will promote the growth of the denser and more stable cubic phase.

The figure below shows the refractive index dispersed between wavelengths 350 nm and 14,000 nm. The high dispersion rate below 500 nm limits the usefulness of ZnS in wide-band designs, and its low dispersion rate at IR wavelengths is an advantage.

### Evaporation Parameters

While Zinc Sulfide can be evaporated by E-beam, thermal evaporation is generally used in optical work. The evaporation temperature is low (800°C), so it is easier to obtain stoichiometric composition using the more gentle thermal technique. Zinc Sulfide is decomposed at the source, and recombination occurs at the substrate if the temperature is near 150° - 175° C and proper nucleation is initiated. At higher temperatures, arriving adatoms exhibit lower condensation rates ("sticking coef.") and as a result large thickness errors between the hot substrate and, for example the crystal thickness/rate monitor, will be experienced. Thorough cleaning of the substrate surface is also essential for good coating adhesion.

Typical resistance-heated evaporation sources are baffled box configurations made



of Ta or Mo. A gentle ramping of the source heating is suggested to minimize dispersion of the components which would inhibit complete compositional recombination. Typical evaporation rates are 10-15Å per second at a background pressure below 10<sup>-5</sup> Torr.

### Advantages and Preparation of CIROM™-2

CERAC's CIROM™-2 Zinc Sulfide is an ultradense polycrystalline substance manufactured by a special process. Its high density (99%+) enables it to evaporate more uniformly and with less particle ejection (spitting) and outgassing than other ZnS material preparations, resulting in higher quality film layers.

Ultradense CIROM™-2 Zinc Sulfide polycrystalline material is prepared from high purity powder by a proprietary pressing technique, using very high pressure and special metallic molds in vacuum. This technique enables CERAC to produce thick pieces in a relatively short time and at reasonable cost, versus the extended periods and higher cost required by chemical vapor deposition processes.

### Purity Analysis of Solid Material

#### Typical Concentration (ppm)

|    |     |
|----|-----|
| Cd | <10 |
| Co | <10 |
| Cr | <20 |
| Cu | < 5 |
| Fe | <10 |
| Mn | < 3 |
| Ni | <10 |
| Pb | <10 |
| Ti | <10 |

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### Physical Properties of Solid Material

|  |   |
|--|---|
| Molecular Weight                         | 97.44   |
| Melting Point                            | Sublimes  |
| Visual Appearance                        | Milky white/ translucent  |
| Transparen Region of thin film coatings  | 0.4-14 µm (400-14,000 nm)   |
| Refractive Index as thin film coatings   | 2.5 at 400 nm<br>2.35 at 600 nm<br>2.25 at 1000 nm<br>2.15 at 5000-12,000 nm                                |
| Hardness                                 | Approx. 354 Knoop (Moh 4.5)   |
| Density at 25°C, g/cc                    | CIROM™-2 (as produced, β,cubic, sphalerite):<br>4.09 typical, measured (compared to 4.102 crystal density). |
| Thermal Conductivity                     | (cal/sec/sec/cm <sup>2</sup> /°C/cm) 0.037 at 54°C 0.026 at 174°C   |
| Expansion Coefficient (length/length/°C) | 6.9 x 10 <sup>-6</sup> (25 to 200°C)  |
| Water Solubility                         | Essentially insoluble. There is no water penetration into solid pieces.                                     |
| Dielectric Constant                      | 8 at 9.0 GHz  |

### Forms and Sizes Available

CIROM™-2 ZnS is available as evaporation pieces, cubes, sputtering targets and customer-specified shapes.

| Item Number | Purity | Description       |
|-------------|--------|-------------------|
| Z-2026      | 99.99% | 3-12 mm pieces    |
| Z-2028      | 99.99% | 9mm cubes         |
| SS-627      | 99.99% | Sputtering target |

To view pricing on our standard catalog items, please visit our on-line catalog at [www.cerac.com](http://www.cerac.com) and search by item number, chemical name or CAS number. If you require a custom manufactured item, please contact our sales department at +1-414-289-9800 or [cerac-sales@beminc.com](mailto:cerac-sales@beminc.com) with your specific requirements. You can also fill out our quotation request form.

### Ordering Information

For specific product information or to place an order, contact CERAC customer service at [ceraccustserv@beminc.com](mailto:ceraccustserv@beminc.com) or by phone at +1-414-289-9800. Visit [www.cerac.com](http://www.cerac.com) for a complete list of global sales and service locations.

*Note: Facts pertaining to properties and processing parameters of ZnS were derived from published literature sources. Although this information is believed to be correct, CERAC does not guarantee its accuracy.*

*CIROM (CERAC Infrared Optical Material) is a registered trademark of CERAC, inc., representing a family of specially prepared thin-film deposition materials.*

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