

■ EKSMA社製非線形光学結晶 AGGAS2, AGGASE2, GASE, ZNGEP2結晶

| Crystal                    | ZnGeP <sub>2</sub> | AgGaSe <sub>2</sub> | AgGaS <sub>2</sub> | GaSe      |
|----------------------------|--------------------|---------------------|--------------------|-----------|
| Crystal Symmetry           | Tetragonal         | Tetragonal          | Tetragonal         | Hexagonal |
| Point Group                | 42m                | 42m                 | 42m                | 62m       |
| Lattice Constants, Å       | a                  | 5.465               | 5.9901             | 5.757     |
| c                          | 10.771             | 10.8823             | 10.305             | 15.918    |
| Density, g/cm <sup>3</sup> | 4.175              | 5.71                | 4.56               | 5.03      |

OPTICAL PROPERTIES

| Crystal                                     | ZnGeP <sub>2</sub> | AgGaSe <sub>2</sub> | AgGaS <sub>2</sub> | GaSe    |
|---------------------------------------------|--------------------|---------------------|--------------------|---------|
| Optical transmission, μm                    | 0.74–12            | 0.73–18             | 0.53–12            | 0.65–18 |
| Indices of Refraction at                    |                    |                     |                    |         |
| 1.06 μm n <sub>o</sub>                      | 3.2324             | 2.7005              | 2.4508             | 2.9082  |
| n <sub>e</sub>                              | 3.2786             | 2.6759              | 2.3966             | 2.5676  |
| 5.3 μm n <sub>o</sub>                       | 3.1141             | 2.614               | 2.3954             | 2.834   |
| n <sub>e</sub>                              | 3.1524             | 2.5823              | 2.3421             | 2.4599  |
| 10.6 μm n <sub>o</sub>                      | 3.0725             | 2.5915              | 2.3466             | 2.8158  |
| n <sub>e</sub>                              | 3.1119             | 2.5585              | 2.2924             | 2.4392  |
| Absorption Coefficient, cm <sup>-1</sup> at |                    |                     |                    |         |
| 1.06 μm                                     | 3                  | <0.02               | <0.09              | 0.25    |
| 2.5 μm                                      | 0.03               | <0.01               | 0.01               | 0.05    |
| 5.0 μm                                      | 0.02               | <0.01               | 0.01               | 0.05    |
| 7.5 μm                                      | 0.02               | -                   | 0.02               | 0.05    |
| 10.0 μm                                     | 0.4                | -                   | <0.6               | 0.05    |
| 11.0 μm                                     | 0.8                |                     |                    |         |

NONLINEAR OPTICAL PROPERTIES

| Crystal                                             | ZnGeP <sub>2</sub> | AgGaSe <sub>2</sub> | AgGaS <sub>2</sub> | GaSe |
|-----------------------------------------------------|--------------------|---------------------|--------------------|------|
| Laser damage threshold, MW/cm <sup>2</sup>          | 60                 | 25                  | 10                 | 28   |
| at pulse duration, ns                               | 100                | 50                  | 20                 | 150  |
| at wavelength, μm                                   | 10.6               | 2.05                | 1.06               | 9.3  |
| Nonlinearity, pm/V                                  | 111                | 43                  | 31                 | 63   |
| Phase matching angle for Type 1 SHG at 10.6 μm, deg | 76                 | 55                  | 67                 | 14   |
| Walk-off angle at 5.3 μm, deg                       | 0.57               | 0.67                | 0.85               | 3.4  |

THERMAL PROPERTIES

| Crystal                                             | ZnGeP <sub>2</sub> | AgGaSe <sub>2</sub> | AgGaS <sub>2</sub> | GaSe |
|-----------------------------------------------------|--------------------|---------------------|--------------------|------|
| Melting point, °C                                   | 1298               | 851                 | 998                | 1233 |
| Thermal Expansion Coefficient, 10 <sup>-6</sup> /°K |                    |                     |                    |      |
| ?                                                   | 17.5(a)            | 23.4(c)             | 12.5               | 9    |
| ?                                                   | 9.1(b)             | 18.0(d)             |                    |      |
|                                                     | 1.59(a)            | -6.4(c)             | -13.2              | 8.25 |
|                                                     | 8.08(b)            | -16.0(d)            |                    |      |

a) at 293-573 K, b) at 573-873 K, c) at 298-423 K, d) 423-873 K

SELLMEIER EQUATIONS FOR CALCULATION OF INDICES OF REFRACTION

| Crystal             |                | A      | B       | C       | D       | E      | F    | Expression                                                                          |
|---------------------|----------------|--------|---------|---------|---------|--------|------|-------------------------------------------------------------------------------------|
| ZnGeP <sub>2</sub>  | n <sub>o</sub> | 8.0409 | 1.68625 | 0.40824 | 1.288   | 611.05 | -    | $n^2 = A + B / (\lambda^2 - C) + D \lambda^2 / (\lambda^2 - E)$                     |
|                     | n <sub>e</sub> | 8.0929 | 1.8649  | 0.41468 | 0.84052 | 452.05 | -    |                                                                                     |
| AgGaSe <sub>2</sub> | n <sub>o</sub> | 6.8507 | 0.4297  | 0.1584  | 0.00125 | -      | -    | $n^2 = A + B / (\lambda^2 - C) - D \lambda^2$                                       |
|                     | n <sub>e</sub> | 6.6792 | 0.4598  | 0.2122  | 0.00126 | -      | -    |                                                                                     |
| AgGaS <sub>2</sub>  | n <sub>o</sub> | 3.397  | 2.3982  | 0.09311 | 2.164   | 950.0  | -    | $n^2 = A + B / (1 - C / \lambda^2) + D / (1 - E / \lambda^2)$                       |
|                     | n <sub>e</sub> | 3.5873 | 1.9533  | 0.11066 | 2.3391  | 1030.7 | -    |                                                                                     |
| GaSe                | n <sub>o</sub> | 7.443  | 0.405   | 0.0186  | 0.0061  | 3.1485 | 2194 | $n^2 = A + B / \lambda^2 + C / \lambda^4 + D / \lambda^6 + E / (1 - F / \lambda^2)$ |
|                     | n <sub>e</sub> | 5.76   | 0.3879  | -0.2288 | 0.1223  | 1.855  | 1780 |                                                                                     |