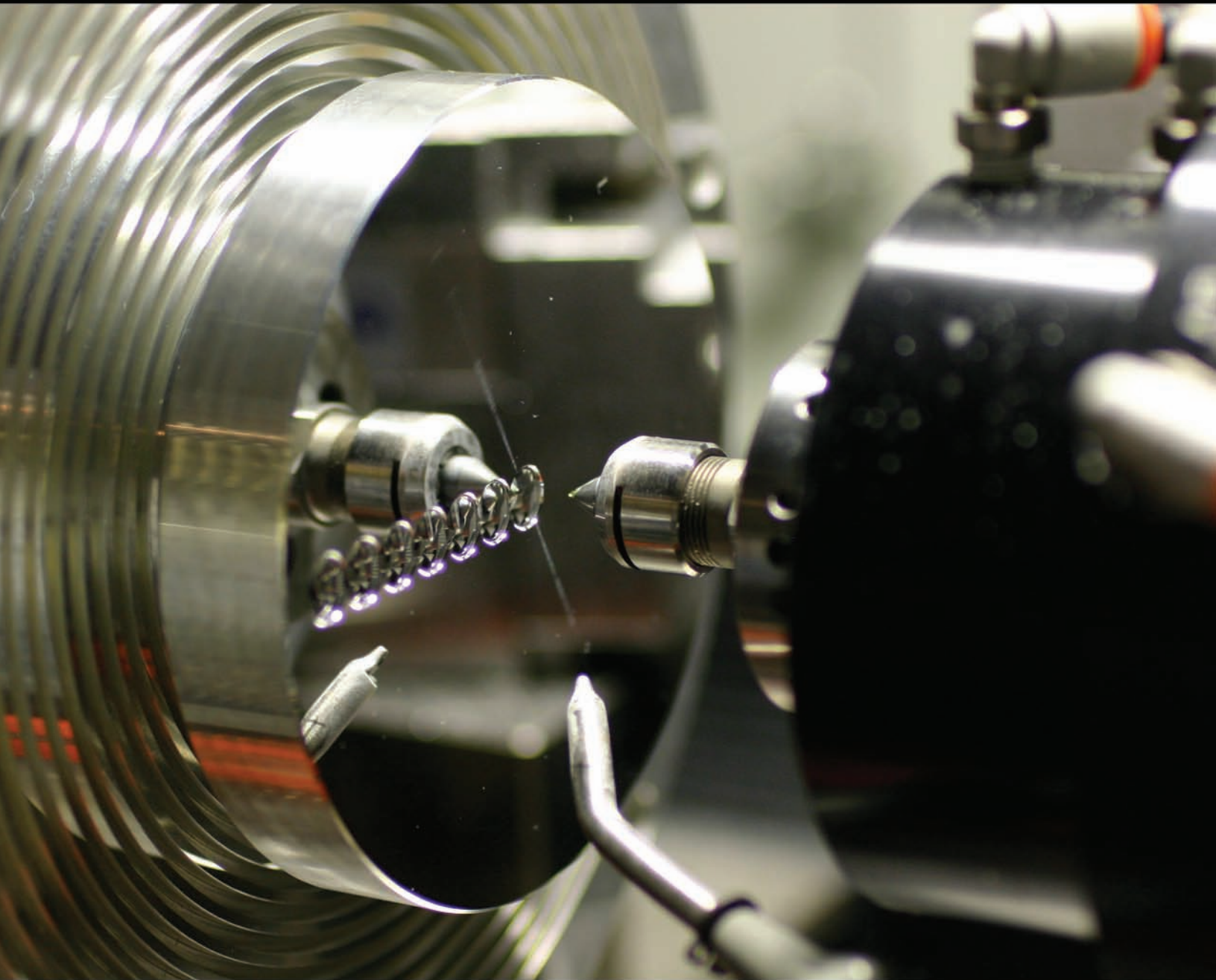




**INFRARED**

**... the world leader in CO<sub>2</sub> laser optics**

# **DIAMOND TURNING CAPABILITIES**



**MULTI-AXIS TURNING • FREEFORM TURNING • MICRO-MILLING**

888.558.1504 (toll-free) • 724.352.1504 (phone) • 724.352.4980 (fax) • [www.iiviiinfrared.com](http://www.iiviiinfrared.com)





## DIAMOND TURNING

The II-VI Diamond Turning facility was established in 1988 with the purchase of a Pneumo MSG500 flycutter. Today, we are an industry leader in diamond-turned components for commercial industry, military, and aerospace customers. Our facility is recognized as one of the largest and most advanced in the world, offering:

- **Flycutting of plano and cylindrical optics**
- **Two-axis turning—up to 700mm-diameter capacity**
- **Fast Tool Servo for non-rotationally symmetric geometries**
- **Slow Tool Servo for extended range, non-rotationally symmetric geometries**
- **4-axis turning - up to 700mm-diameter capacity (X,Z,B &  $\theta$ )**
- **Dedicated cleaning facilities**
- **Supported by II-VI INFRARED thin-film coating, design and assembly capabilities**



## VERTICAL INTEGRATION

Our customers also benefit from the vertically-integrated optics manufacturing environment of II-VI, the world leader in CO<sub>2</sub> laser optics. This integration includes:

- **Optical materials growth**
  - ZnSe, ZnS, and ZnS MultiSpectral
- **Optics fabrication**
  - High-speed polishing
  - Traditional polishing
  - Planetary polishing (single and double)
- **Thin-film coating**
- **Assembly**
- **Optical and mechanical design**



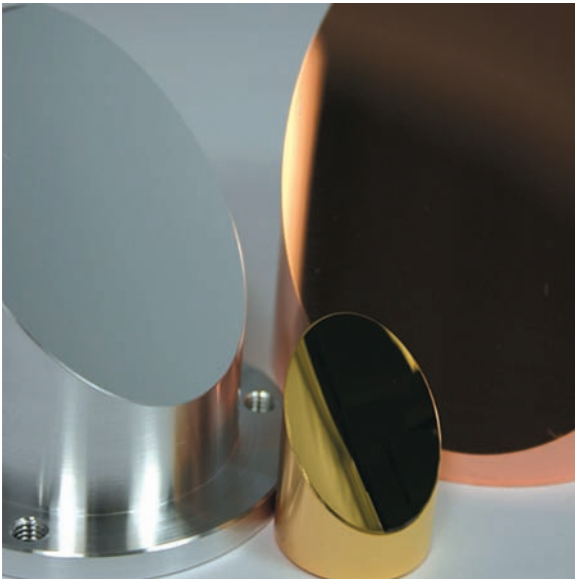


## SINGLE-AXIS FLYCUTTING

II-VI uses single-point diamond flycutting machines with CNC controllers capable of producing high-volume plano (flat) geometries. We have the capability to produce surface finishes on OFHC copper of less than 50 Angstroms RMS, surface finishes on 6061 aluminum of less than 60 Angstroms RMS, and figure accuracies of  $\lambda/4$  peak-to-valley at  $0.6328\mu\text{m}$  on both materials.

Products include:

- **Prototype and high-volume products**
- **Laser beam delivery mirrors**
- **Laser cavity mirrors**
- **Steering and head mirrors for military/aerospace**
- **Deformable mirrors**
- **Faceted lenses and mirrors for laser beam integration**
- **Components for space and cryogenic applications**
- **Cylindrical optics.**

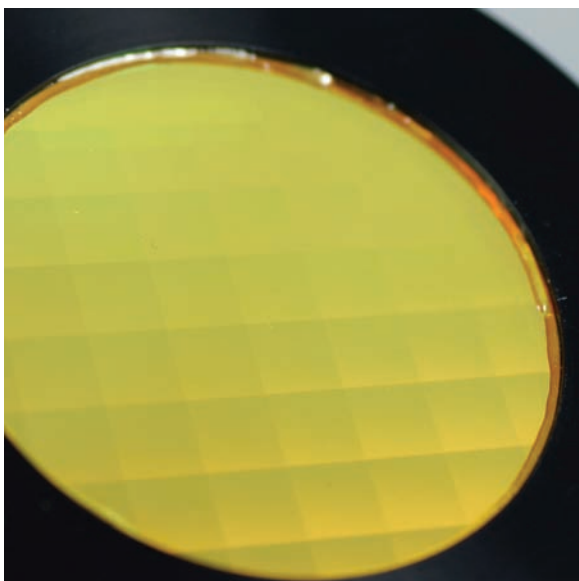


## TWO-AXIS TURNING

All of our two-axis lathes are CNC controlled with positional resolution of 0.008-1.25nm. Our largest format lathe is the Nanoform 700, which is capable of producing on-axis parts up to 700mm (28 inches) in diameter and weighing up to 250 pounds. The Nanoform 700 is capable of surface finishes of less than 20 Angstroms RMS and figure accuracies of  $\lambda/6$  peak-to-valley at  $0.6328\mu\text{m}$ .

Products include:

- **Prototype and high-volume products**
- **Parabolic beam focusing optics**
- **Spherical mirrors for laser cavities**
- **Aspheric focusing lenses**
- **Telecentric lenses for micro-via drilling**
- **Reflective beam expanders**
- **Reflective telescopes and seeker/sensor optics**
- **Lens arrays**



## FREEFORM TURNING

Non-rotationally symmetric geometries are now possible through the utilization of fast and slow tool servo technologies.

### FAST TOOL SERVO (FTS)

Up to  $70\mu\text{m}$  of departure from rotational symmetry can be realized using a piezoelectric fast-tool device. Fast tool servo processes are capable of producing RMS surface roughness less than 50 angstroms and figure accuracy less than  $0.2\mu\text{m}$  peak-to-valley.

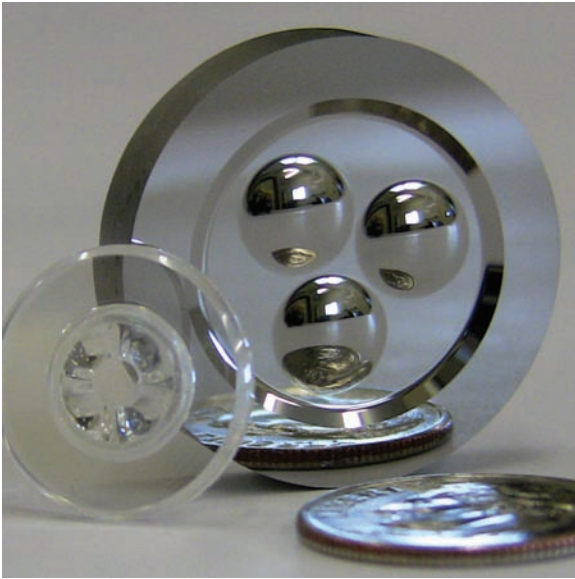
### SLOW TOOL SERVO (STS)

For non-rotational symmetry greater than  $70\mu\text{m}$ , slow tool servo technology is applicable. Components with departure of 3mm have been successfully diamond turned at II-VI. RMS surface roughness less than 100 angstroms and figure accuracy less than  $0.2\mu\text{m}$  have been realized using slow tool servo technology.

II-VI Diamond Turning has successfully integrated FTS and STS technologies simultaneously. This enables us to machine multiple geometries onto a single optical surface.

Products include:

- **Toroidal lenses and mirrors**
- **Off-axis conics and aspheres, working distances >300mm to infinity**
- **Spheric or aspheric cylindrical lenses and mirrors**
- **Ring focusing lens and mirrors**
- **Micro-lens and micro-cylindrical lens arrays**
- **Free-form wavefront correctors**
- **Reflective and transmissive multifaceted beam integrators**
- **Lens arrays**



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## FOUR-AXIS TURNING

The ever-changing needs of optical designers requires technology that can keep up with this evolution. II-VI's 4-axis diamond turning machining incorporates B-axis freedom to expand our capabilities into brand new arenas. This lathe can support parts up to 700mm (28 inches) in diameter. The hydrostatic oil bearing B-axis incorporates a rotary action orthogonal to the X-Z plane with a range up to 350mm in diameter. This technology permits tool-normal manufacturing for steep radii and can be coupled with our Fast Tool and Slow Tool Servo technologies to support various non-rotationally symmetric geometries.

- **Prototype and pre-production**
- **B-axis slow tool servo diamond turning**
- **Steep radii lenses, mirrors and molds**



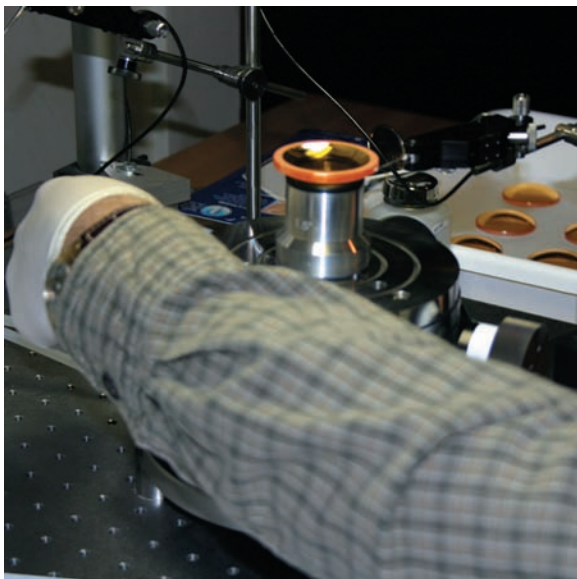
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## MICRO-MILLING/MICRO-GRINDING

Freeform diamond turning takes on new meaning with the advent of micro milling and micro grinding capabilities. By incorporating a high speed tool spindle into a 4-axis diamond turning machine, freeform design can invade areas once thought impossible for the optical designer. Furthermore, this capability simplifies and improves efficiency and accuracy for designs that once required complicated tooling and assembly. This technology transcends optics by affording us the capability of creating precision structures and microstructures for a whole range of applications.

Products include:

- **Microlens arrays**
- **Diffractive optics**
- **"Fly's Eye" structures**
- **Fluidic structures**
- **Optical molds**
- **Gratings**



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## METROLOGY EQUIPMENT

- Rank Taylor Hobson S5 Form Talysurf Profilometer
- Talysurf PGI 1240
- Zygo Interferometer Model Mark IV w/6.0" aperture
- Zeiss Eclipse 550 ST Coordinate Measuring System
- Zygo New View 100 and 5000 3-D Imaging Surface Structure Analyzer
- Zygo Interferometer Model GPI XP w/4.0" aperture
- Zygo 10.6 $\mu$ m IR interferometer
- Zygo and HP distance measuring interferometers
- Heidenhain Rod 800 Rotary Table
- Ultra Dex Indexing Table
- Precitech Ultracomp Metrology
- Range of spectrometers for reflectivity and transmission tests (UV to IR)
- Tunable CO<sub>2</sub> lasers for precision reflectivity and transmission testing
- CO<sub>2</sub> laser calorimetry
- Environmental chambers
- Other mechanical and optical instruments



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## THIN-FILM COATING

Our thin-film coating facility completes our vertically integrated component capability so that optical fabrication, diamond turning, and coating are all performed at the same site. The coating lab has been designed to include a full line of precision cleaning equipment, and clean room practices ensure that particulate contaminations are minimized. Computer-controlled coating machines provide consistent process control and help ensure our coatings meet the customer's quality, durability, and cosmetic requirements.

Products include:

- Custom coating designs
- High-efficiency broadband anti-reflective coatings
- High damage threshold low-absorption laser coatings
- Very high reflectivity mirror coatings
- Broadband beamsplitter coatings

## GEOMETRIES

	Materials	Flycutting	Two-Axis and Freeform		
<b>Metal Optics</b>	copper aluminum AlumiPlate™ electroless nickel brass	plano pyramidal polygon multifaceted cylindrical	spherical parabolic hyperbolic elliptical aspheric	diffractive toroidal cylindrical axicon/waxicon non-rotationally symmetric	faceted arrays helical
<b>Transmissive Optics</b>	germanium zinc sulfide zinc selenide silicon acrylic	plano pyramidal polygon multifaceted cylindrical	aspheric diffractive axicon non-rotationally symmetric	arrays helical	



- |   |                                  |   |
|---|----------------------------------|---|
| 1. Al telescope mirror                                  | 9. Cu output scrapper mirror     | 18. ZnS MS negative meniscus asphere lens |
| 2. Cu helix   | 10. Cu spiral mirror             | 19. Parabolic replica mold                |
| 3. Al off-axis parabolic                                | 11. ZnSe vortex lens             | 20. Ge lens                               |
| 4. ZnSe diffractive asphere lens                        | 12. Al parabolic mirror          | 21. Cu button mirrors                     |
| 5. Cu phase retarder                                    | 13. Cu rooftop beamsplitter      | 22. ZnSe transmissive beam integrator     |
| 6. Cu Total Reflector                                   | 14. Al off-axis parabolic        | 23. Cu reflective beam integrator         |
| 7. 45° pressure controlled variable radius mirror (VRM) | 15. Al reflector                 | 24. Cu tophat                             |
| 8. Cu waxicon   | 16. Cu toroid rear reflector     |   |
|   | 17. ZnS MS asphere meniscus lens |   |

## **WORLDWIDE SALES OFFICES**

To place an order, contact a II-VI sales representative at any of the following locations, or log onto [www.iiviinfrared.com/contact](http://www.iiviinfrared.com/contact) for our most complete and up-to-date contact information.

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