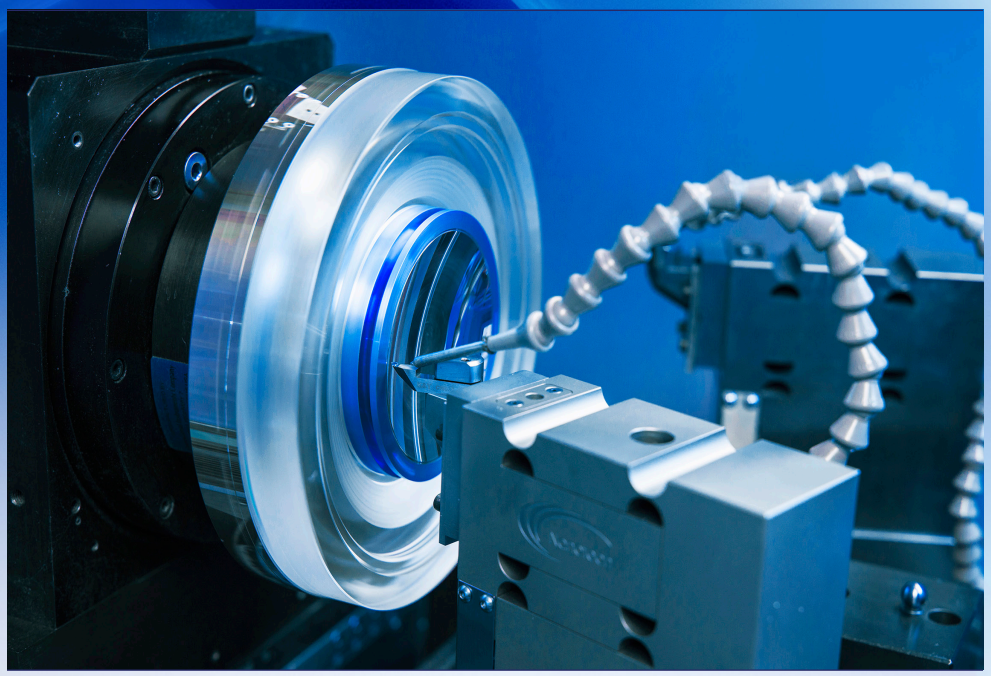

Single Point Diamond Turning (SPDT):
A Singular Solution for Precise Optics Prototyping

EMPIRE PRECISION

Growth of Injection Molded Optics

Precision polymer optics are recognized as the leading edge of the injection molding industry. However, only a handful of molders so far are able to continuously achieve optical accuracies in wavelengths of light.

Plastic injection molding offers several advantages for optical systems, including reduced size and weight, improved quality and safety, and a more cost-effective ramp to full-volume production. While a lens conversion alone is beneficial, the biggest cost savings result from a redesign that eliminates or minimizes optical mounts, hardware, optical alignment and assembly.

There are circumstances in which optics aren't an obvious fit for injection molding, such as projects that involve:

- Low volumes
- Engineering models for design verification
- Extreme precision requirements

Fortunately, there is a solution for these cases: **single point diamond turning (SPDT)**.

What is Single Point Diamond Turning?

Diamond turning is the process of manufacturing precision components using a single diamond point tool affixed to a linear side, mounted on a granite table that comes in contact with the rotating material riding on an air-bearing spindle.

The increasing need for large-diameter reflectors mandated the development of a machining process that could fabricate high quality optical surfaces on metal substrates. SPDT was able to meet the need for exceptionally high geometrical precision, combined with extremely smooth surfaces, better than conventional optical processing.

Today SPDT is used for optical design, product development prototypes, or engineering models in order to:

- Verify design performance without the expense of building a tool
- Meet low-volume part requirements where production molds are not cost-justified
- Add flexibility to the product development process

Good Fits for SPDT

- Aspheric or paraboloidal surfaces
- Free-form optics (non-rotationally symmetric surfaces)
- Micro-lens arrays
- Fresnel lenses consisting of a series of concentric grooves
- Refractive-diffractive optics (two or more surface levels)
- Toroids or focusing surfaces (two different radii with axes oriented at 90° to each other)

Benefits of Prototyping with SPDT

- **Fast Turnaround:** SPDT enables the trial of multiple scenarios quickly, reducing the overall product development cycle by weeks or even months.
- **Low Cost:** Using SPDT, plastic optical designs can be created without first building an expensive injection mold, saving development costs as well as time.
- **Fewer Design Constraints:** Molding applications of SPDT are rapidly growing. Because SPDT prototypes are fabricated from an ultra-precise insert, many complex configurations that can be machined into the insert can be made cost-effectively into precision polymer optics. This enables engineers to design complex optics for use in imaging, scanning, detection, or illumination systems.
- **Reduced Tool Wear:** Tool wear is a critical factor when machining precise optical components. Due to their hardness, diamond tools are more resistant to wear and can therefore maintain precise quality for longer.

SPDT Capabilities and Requirements

Tolerance

Tolerances can be held very tightly using SPDT. It is possible to machine an optical surface accuracy of λ/4 peak to valley, with surface finish as low as 50 Å rms in bare aluminum and as low as 25 Å rms with nickel plating.

Best-fit Materials

Material selection can often be a decision point for the designer. There are a few polymer materials that diamond turn successfully for lens elements. Some of the more common are acrylic, polystyrene, and zeonex (cyclic olefin). Polycarbonate is a great optical lens material; however it does not diamond turn well for prototype and development use. When PC is specified by the lens design, we can substitute polystyrene for the development samples by tweaking the optical prescription slightly.

Mounting & Features

If a part includes a lot of mounting and peripheral features, it might be difficult to machine the lens area by diamond turning; a 2-piece interim design might be necessary. This scenario could rule out SPDT other than to build a prototype tool to mold the samples. Using our internal capabilities, Empire can build cost-effective and rapid molds to accomplish this phase, if needed. Aluminum and similar alloys can be diamond turned and are used extensively for developing mirrors, parabolic reflectors, etc.

If it works for your design, diamond turning is an ideal optical prototyping option that saves time and money. Contact us at 1.800.541.7135 or info@empireprecision.com to discuss using SPDT for your program.

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