The Optical Solutions Company

Company Overview
Background & Core Competencies
• 1985 - Integrated Solar Technologies Corp., formed in Taos to improve solar energy technology – led to first proprietary product, Gradium glass
• 1989 - ISTC changed its name to LightPath Technologies
• 1996 - LightPath goes public (NASDAQ: LPTH)

• 1988 - Geltech is founded on sol-gel optics fabrication
• 1994 - Corning sells its Lens business to Geltech
• 2000 (Sept) - LightPath acquires Geltech

• 1996 - Horizon founded on Isolator Assembly
• 1997 - 2000 - Horizon’s provides 100% of Lucent’s isolator requirements
• 2000 (April) - LightPath acquires Horizon

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Over 20 years in the optics industry

focusing on optical solutions
About LightPath

- Publicly traded since Feb 1996 (NASDAQ: LPTH)
- Presently 100 Employees
- Headquartered in Orlando Florida
- Distributors & Representatives in US, France, Germany, UK, Sweden, Italy, Israel, Japan, Singapore, Thailand, China, Malaysia, Hong Kong, Viet Nam, Canada and now India

- Sales Locations: Orlando, FL; Little Falls, NJ; Huntsville, AL; San Diego, CA; Lannion, France; Shanghai, China
- Fast 500 award Deloitte Technology award
- 58 US Patents Issued & 8 Pending
LightPath Covers the World

- Direct Sales West USA
- Direct Sales Central USA
- Direct Sales East USA
- LPTH Mfg Orlando Florida
- LPTH Mfg Shanghai China
- Direct Sales Europe, France
- Direct Sales China

= LPTH Reps and Distributors

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focusing on optical solutions
Corporate Headquarters

Orlando, Florida

- Facility totals 12,000 square feet
- 8,000 square feet of clean room
- ISO 9001-2000 Registered
  - Precision Molded Aspheric Optics
  - IR Molded Optics
  - Isolators
  - GRADIUM® Optics
  - Collimators
  - Molded Glass Lens Array
  - Integrated Optical Assemblies
  - Traditional Optics
LightPath Technologies Shanghai Co. Limited
(Wholly owned facility of LightPath Technologies USA.)

Location: Shanghai

Capability: Large Volume Aspheric Traditional Optics

Facility: 17,000 sq feet
12,000 sq foot clean room
5,000 sq ft office
Cafeteria on first floor

Opening: Q4, 2005
Qualification November 2005
Q1, 2006 Production Ramp
Q2, 2006 Full Production

Role: Mfg: High volume, higher labor content, low labor cost
Purchasing: Material consolidation

Sales: Asia sales headquarters

Key Personnel: Plant Manager Joe Wu
LightPath Technologies Shanghai Co. Ltd.

1365 Hong De Road, Building C3
Jiading Industrial Zone, Shanghai, China
201821
At the most basic component level form typical Optical systems are made up of 3 groups: Making Light, Managing/Processing Light and Measuring Light.

LightPath addresses a major portion of managing light.

We are experts in the optical portion of managing light - we do not address vibration control, motion control or mechanical - we just perfect the optics and broaden the portfolio.

Make Light | Manage/Process Light | Measure Light
Laser → Optics → Imaging

Historically only Optics, for Laser & Laser diodes---now expanding into Imaging, UV through IR.
LightPath is Vertically Integrated

**Background**
- Purchased Corning Glass’ Precision Glass Molding (PMO) assets and patents in 1994
- Over 20 years of research and development including over 15 patents
- Internally produced manufacturing tooling and molding equipment

**Vertically Integrated**
- Design and build our own press equipment in-house
- Dedicated team for optics design in-house (Orlando and Shanghai)
- Optics simulation and verification all done in-house
- In house diamond turning and micro-grinding for high performance molds
- High Performance Lasers & Imaging applications are our business
- Shanghai in production since May 2006
- Present Shanghai capacity is 2,600,000 lenses/year
- Press technology is quickly scaleable for millions of lenses/month
- ISO 9001-2002 registered
Business Life Cycle Support

LPTH Technologies is Quick to Volume

- Prototypes have now been customer qualified
- Hard tooling begins
- Transition to LightPath’s China high volume production facility begins

- Delivery of prototypes in as little as 4 weeks from beginning of design
- Customer evaluates lenses before volume production begins
- Soft tooling is now completed

- LightPath’s in-house optical design staff can design lens or co-design with customer
- Design package goes through customer approval process
- Vertically integrated for raw materials and tooling fabrication
• Aspheric Lenses
• Aspheric Lens Arrays
• TxAspheres
• Hybrid Lenses
• CircuLight™
• Black Diamond™

• ECO550 - Lead-Free Glass
• C0550
• PBH71
• Chalcogenide – IR Glass
• Radiation Hardened Glasses

• LightPath’s glass molding technology was originally acquired from Corning Inc. in 1994

• Dedicated optical design teams

• Rapid development from prototypes to volume production

• LightPath has established facilities and technology providing single point diamond turned molds and glass molding presses
Standard Product – Aspheric Lenses

- Lens Diameters from 200μm to 15mm
- Over 40 designs in stock
- Numerical Apertures up to 0.85
- AR Coatings with Reflection <0.15 % per surface
- Diffraction Limited Performance
- Integrated Metallic Structure and Optics
- Hybrid Lens / Diffractive on Refractive Profile
- Anamorphic Designs
Custom Aspheric Lenses

- Lens Diameters from 200μm to 25mm
- Numerical Apertures up to 0.85
- Custom AR coatings
- Variety of glasses for different designs and applications
- Delivery typically less than 10 weeks
- LightPath will design or co-design with customer
- Customer approval of design package
- Prototypes delivered for customer evaluation
- Production volumes 6-12 weeks after approval
Precision Performance – How does it benefit the customer?

**O.D Tolerances +.000/-.001 mm**

Tooling establishes outer diameter and lenses do not need secondary processing steps such as edge grinding.

**Optical Centration .003 mm**

**Increased Yields and Productivity**

This precision capability is many microns ahead of any state of the art plastic precision molding currently available. Precise tolerances lead to greater yields and increase manufacturing productivity in producing aspheric lens assemblies such as low cost high performance digital imaging products. Tolerances can allow for high yield, drop-in-place assembly with little or no active alignment.
Diffractive Technology (Kinoform)

- Reduces lens count
- Shortens optical system length, allowing more compact designs
- Reduces chromatic and geometrical aberrations

MIP Technology

- Mold-In-Place technology allows glass to be directly molded into mechanical structures such as stainless steel
- Rugged and compact lens assemblies can be easily manufactured using this technology
- Allows automated YAG welding operations for true automated assembly of waterproof or hermetic lenses
• Metro, Long Haul and Hybrid Fiber Coax transmitters

• Precision molded high index glass (C0550 or PBH71)

• Aspheric profile

• Diffraction limited performance

• Square lenses for ease of mounting

• High volume wafer-scale manufacturing

• Numerical apertures up to 0.60

• Clear aperture up to 1.5mm

Example: 250 micron Asphere at 250 micron pitch
Molded Glass Lens Array

- Lens to lens pitch tolerance < 1µm
- Effective focal length tolerance < 1%
- Diffraction limited performance
- Custom aspheric profiles
- Custom 1 x n and n x m configuration
- Low or high numerical aperture
Black Diamond™ LWIR Aspheres

Key Facts

- Wavelength Range of glasses 1 – 14\(\mu\)m
- Diameter up to 15mm currently, up to 25mm in Development
- Aspheric Lenses Reduce the Lens Component Count in System
- Molded Optics Improved reproducibility lens to lens
- Diffractive Features for Thermal Compensation (future)
- Improved Transmission at Elevated Temperature
- Can mold optic into holder
- Low Dispersion
- Custom Designs Available
LightPath is working in conjunction with the Navy, Air Force, & Lockheed Martin to develop a molding process for larger infrared lenses through the SBIR program.

**SBIR Topic N06-025**

Molding Technology for Low-Cost Infrared Chalcogenide Glass Optical Components

**Phase 1 Completed**
Feasibility of Molding Chalcogenide Delivered Molded Samples

**Phase 1B Completed**
Deliver production units

**Phase 2 Pending**
Larger Diameter Molded Lens Proposal Under Review
LightPath Advantages

- LPTH designed and produced its mfg equipment
- LPTH designed and produced all tooling in house (48hrs)
- Highly accurate, precision molding for performance
- No post processing operations on glass lenses (edge grinding, etc)
- Scalable process, prototyping to production capacity
- Less expensive capitalization versus commercial pressing systems
- Labor easily trained, minimal skill set required, time to production is short
- Multiple sources of glass supply
- Vertically integrated mfg
- China operation is up and running today and ISO registered
- Ability to mold into mechanical holders
- Over 20 years experience in Molding Precision Glass Optics from Corning
- In house optical and mechanical engineers both in USA and China
Other LightPath Products
The LightPath Fusion Advantage

- High Power Capability
- Patented Automated Assembly Process
- Scaleable Sizes Available
- Low Back Reflection
- Low Insertion Loss
- No Epoxy In Optical Path

LightPath’s® Patented Fusion™ Technology

LightPath’s® patented process fuses the silica fiber directly to a large silica rod. In applications involving Comin® HI1060 fiber, light expands within the silica rod and exits in an area 12,000 times larger than the competitive collimators – greatly reducing the power density and improving the reliability at higher power levels.

Competition

- Air gap causes excess back reflection
- Epoxy may be in optical path
- Higher insertion loss due to no asphere
- Process not highly automated

Traditional Angle Cleaved Fiber Collimators

Light exits fiber tip and expands in air until collimated by the spherical lens. Using Comin® HI1060 fiber as an example, energy is concentrated in an area on 6.2mm in diameter at the exit fiber tip. Sub-micron defects from contamination, polishing, or AR coating the fiber will have catastrophic consequences at high power. In this type of system the fiber must also be angle polished and non-coaxial to the package in order to reduce back reflections.
Automated Laser Polishing

- Laser Polishing
- Silica Lens
- Aspheric Profile
- Automated
- 400 Lenses/Pallet
- CO₂ Laser
- Five Seconds/Lens
Laser Fusion to Fiber

- Fiber Cleave and Strip
- Active Alignment
- Laser Fusion of Fiber to Back Surface of Lens
- Adhesive/Dispense Cure
- Automated Testing
GRADIUM® Product Highlights

- Axial Gradient Index
- 5mm – 100mm O.D.
- Aspherical performance utilizing spherical manufacturing
- Excellent for high power laser applications
- Achromatic available
- Low CTE Glass
- Most Standard Lenses are Available in ZEMAX
- Full Line of Catalog Lenses and Custom Lenses Available
GRADIUM® Glass Diffusion Process

**Stacked Glass Layers** (of varying refractive indexes)

**Gradient Index Lens Blank** (of varying refractive indexes)

Refractive index profile of diffused gradient lens blank
Spherical Aberration Correction

GRADIUM® Lens

Standard Spherical Lens
Optical Isolators

Free Space Isolators

Micro-Fixture Platform for Epoxy Free Optical Path

Low Cost Laminate Platform
Automation Isolator Platform

- Automation Platform
- Proprietary Pallet Technology
- Pick and Place
- Laser Welding
- Test
Oasis™ Asphere/Isolator

- Asphere + Isolator Module
- Laser-to-fiber Coupling
- Single and Multiple Stage Isolator
- Small Form Factor
- Surface Mount Compatible
- Isolation > 40db
- Products for 1550nm and 1310nm
- Custom Products and Wavelengths Available
Eco-Aspheres and Isolators

- European RoHS Directive goes into Effect July 1st, 2006
- Banned Substances
  - Lead, Mercury, Cadmium, Chromium, PBB, PBDE
- LightPath Isolators Already Comply with Regulation
- LightPath Aspheric Lenses in production with New Lead-Free Glass (ECO550)
- Provides Environmentally-Friendly Components without Sacrificing Performance

RoHS ✔️
Quality Management System

- ISO 9001:2000 Re-Registered in December 2004-Orlando
- Current products in ISO System:
  - Precision Molded Aspheres
  - GRADIUM® Lenses
  - Large Beam Collimators
  - Isolator Inspection and Manufacturing procedures
  - Isolator Reliability Plan Document
- Planned additions:
  - Small Beam Collimators
  - Remaining Isolators
- Quality System documentation is accessible via our ISONET system:
  - Terminals throughout the building.
  - Accessible also through any computer.
  - Incorporates procedures, work instructions, engineering drawings, specification documents, internal audit schedule, steering committee meeting minutes.
LightPath is a leader in Molded Glass Aspheric Lenses

- Vertically integrated
- Over 20 years optics industry experience
- One of the first molded glass aspheric companies in China
- High performance molded glass aspheres for Lasers & Imaging
- LightPath technology is scaleable to millions of lenses/month
- Experience servicing Top Tier accounts
- Quick to Market
- Quick to Volume
- We are investing in Autoliv for the future
Thank You