



# Linden Photonics Inc.

THE MACROSCOPIC MANIFESTATION  
OF MICROSCOPIC PHENOMENA



# Mission

Linden Photonics, Inc. strives to be at the forefront of technology, specializing in the manufac-



ture of rugged, robust optical cables that use new and novel jacket material designed for deployment in harsh environments. Our objective is to be a strategic partner to agencies of the Department of Defense, their prime contractors, and advanced technology firms; to develop and deploy cost effective optical tether solutions



that are enabled by incorporating Linden's proprietary, ruggedized optical cable technology.

# What We Do Best

We complement the internal research and development of our customers using our inter-disciplinary experience and agility by developing innovative yet relevant technology outside the confines of large corporations. We strive to qualify technology expeditiously to a DoD Technology Readiness Level of 5 or 6 and transition it to prime contractors for commercialization.

# Sustainable Competitive Advantage

The members of Linden Photonics have been involved in the optical communications industry for over 30 years, performing research in optical fiber fabrication and cabling, integrated optics, fiber sensors & myriad passive optical components. Linden has developed core competency in the extrusion of Liquid Crystal Polymer (LCP) resins over optical fiber. Although much information exists on molding of LCPs, little is known or reported on extrusion of LCPs, particularly of structures with small dimensions.

Linden has gained valuable knowledge relating to the mechanical properties of various LCP resins, and the way in which these properties vary with tool design, process temperature, speed of extrusions and filler materials. Furthermore, we have developed knowledge of the radiation resistance and moisture barrier properties well beyond that available prior to our research. These core competencies are directly related to developing optical cable for markets such as DoD torpedo guidance, ocean floor exploration, and communication buoys. Potential commercial markets are oil drilling and exploration, chemical sensors, electro-optical packaging and virtually any environment requiring rugged compact cable.

# Intellectual Property

Linden has patents issued and pending on optical fiber structures using LCPs as primary or secondary buffers. These patents, along with our knowledge of LCP extrusion and molding, give Linden a significant lead in LCP packaging and cabling technology.

Linden continues to develop, demonstrate new technology and file for patents. We also cultivate, monitor and maintain a circle of sub-contractors to provide services such as extrusion, connectorization, and winding. We test products in-house to stringent specifications and what emerges is a product qualified for DoD applications.

# Core Competencies

LCP jacketed optical fiber cable also has great potential in the area of packaging for electro-optic devices. One of the major challenges facing the packaging engineer is that of creating the hermetic seal around the optical input and output ports. LCPs have excellent barrier properties, are easily molded with great precision, and being thermoplastic, can be bonded with relative ease. It is therefore possible to use LCP both for the hermetic packaging and the fiber jacket. This monolithic approach has the advantage that no special preparation of the fiber is required. Expensive metallized pigtailed can be replaced by short lengths of LCP jacketed fiber which is robust and easy to handle.

Linden prides itself on having introduced innovative, high-quality optical cable products for demanding torpedo guidance, communication buoy and hybrid remotely operated vehicles (HROV). We design and develop high-strength, moisture and radiation resistant, cost-competitive packaging components and optical fiber cable using patented liquid crystal polymer (LCP) buffers. Our products provide quasi-hermetic, radiation resistant packages for the military and commercial telecommunications and sensor markets.

# Products

## Strong Optical Cables

Linden has developed a proprietary Strong Tether Fiber Optic Cable (STFOC™) for torpedo guidance applications which can be manufactured at a fraction of the cost of existing cables. The closest competing product, FOMC (also called Ruggedized Microcable™ Tether Cable) is cost prohibitive for even military applications. Linden's cable, STFOC, is only a fraction of this cost and is a drop-in replacement for FOMC for many applications. STFOC at 30 mil diameter has a breaking strength of over 50 lbs and can be deployed at high speeds through metal umbilicals.

## Hermetic Optoelectronic Packaging

Linden's molded LCP near-hermetic packages for use in optoelectronic components are a replacement for the more costly and traditional ceramic and metal packages. Linden's proprietary LCP buffered fiber is used as pigtailed and, where it exits the package, sealing is achieved with ultrasonic bonding. Packaging is often 60 to 80 % of the cost of an optoelectronic component. Near-hermetic LCP packages eliminate the need for expensive ceramic and metal packages and expensive metalized fiber pigtailed. They provide high temperature performance and the ability to mold precise micron scale features into the molded parts.

## Buoyant Fiber

Linden has also developed thin, buffered optical cable for sea-surface communication buoys and hybrid remotely operated vehicles for ocean bed exploration. Linden's cable is small diameter, high specific strength and buoyant. Linden works closely with other DoD contractors to enable precision spooling of thin optical cable that can be deployed at high speeds.

## Other Products

We now provide connectors and molding services and Linden continues to develop innovative products in the area of polymer technology. Linden continues to develop innovative products in the area of polymer technology. Contact us to see how we can meet your needs.







# Partners

## DoD Prime Contractors

A small business must evolve strategies to have its technology deployed in DoD systems and strength of technology alone is rarely sufficient to achieve this goal. To this end, Linden partners with DoD primes that are potential end-users of the technology under development. Linden has developed strategic relationships with companies such as Lockheed Martin, Bell Helicopter, BAE Systems, Boeing and Goodrich.

## Corporations

Optical cables are also used extensively in the operation of underwater vehicles, referred to as Remotely Operated Vehicles (ROVs). These vehicles are connected to the surface ship via a composite tether cable that consists of electrical cables for power and control and optical cables for data and real time video imagery. The optical cables are usually much thinner than the electrical cables and typically reside in the interstices between them. It is critical that the optical cables be both high strength and flexible. The correct combination of these qualities allow our optical cables to survive the compressive forces that result from fabrication and deployment of such a composite tether. Linden's LCP jacketed optical cables are ideally suited for these applications and are a basis for partnerships with ROV and underwater tether cable manufacturers.

# Company Profile

Headquartered in Westford, MA, Linden Photonics, Inc. was founded by Dr. Amaresh Mahapatra in 2002.

Dr. Amaresh Mahapatra, President of Linden Photonics, was also the founder of RAMAR CORP, which was spun off from Polaroid Corp in 1988. RAMAR CORP was in the business of developing and marketing lithium niobate, integrated optic modulators to speeds of 20 GHz. RAMAR CORP was acquired by JDS-Uniphase in October, 1999. Dr. Mahapatra has 18 patents pertaining to optical cables, integrated optic and fiber optic components and systems.

Stephen O'Riorden, Director of Business Development, graduated from the University of Massachusetts with a BS & MS in Physics, and began his career in optics working with both Volpi Manufacturing USA and Welch Allyn Lighting Products Division designing optical systems, machine vision and industrial/medical lighting & sensor systems for Fortune 500 companies Textron Systems & Rockwell Automation among others. At Diamond USA Stephen managed the North American sales team and continued designing passive optical components and assemblies for the medical, military and industrial markets. Most recently, Stephen held a global position with SENKO Advanced Components leading a product management team and designed many new passive optical components. He holds 3 US Patents and has 3 Patents pending.



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