

Growth of Single Crystal Ferroelectric Fiber and Tapers for All Fiber Network Applications

Our Approach

Laser Heated Pedestal Growth technique for the growth of undoped and Er, Ce, Yb-doped, or Mg- indiffused ferroelectric LiNbO₃ crystal fibers and tapers for effective integration into uninterrupted all-fiber optic network links.

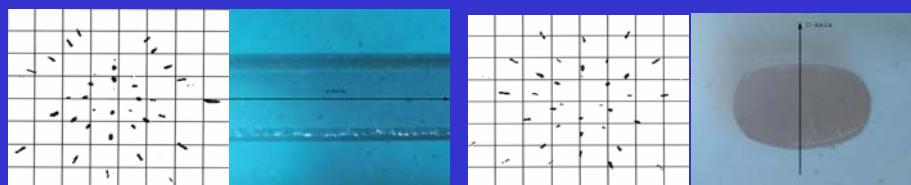
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The LHPG Advantage

- No contamination problems from crucibles
- High growth speed;
- Precise controllability of fiber diameter;
- Both congruent or incongruent crystal can be grown

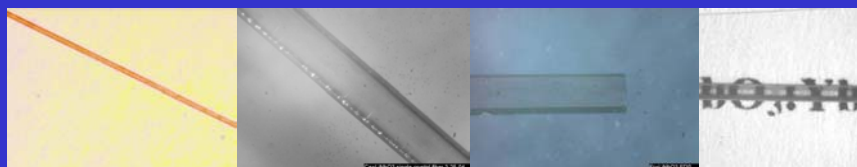


Laser Heated Pedestal Growth (LHPG) Station at MRI, Penn State



Laue X-ray back reflection result for [100] orientation

Laue X-ray back reflection result for [001] orientation



LiNbO₃ single crystal fiber

Ce doped LiNbO₃ single crystal fiber

Er doped LiNbO₃ single crystal fiber

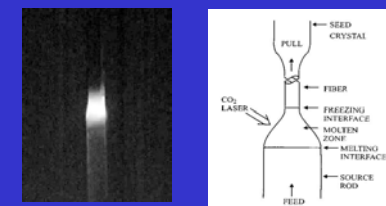
Yb doped LiNbO₃ single crystal fiber



LiNbO₃ tapers

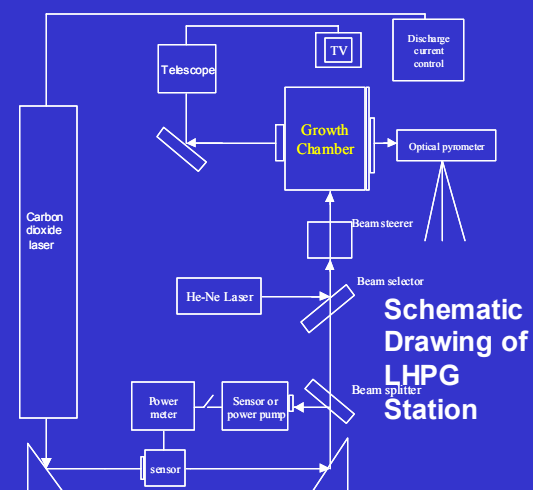
LiNbO₃ Crystal Tapers

Twisting structure of LiNbO₃



Typical LHPG Growth Parameters for a-axis LiNbO₃ Single Crystal

Length of Preform	30~45mm
Diameter of Preform	0.3~0.7mm
Seed Orientation	[100]
Pulling Speed	70~180mm/hr
Feeding Speed	45~55mm/hr
Power	1.2~3.0w CO ₂
Dimension of grown LiNbO ₃ crystal fiber	D _{//001} ≈ 120~350μm; D _{⊥001} ≈ 160~450μm Length upto 130 mm

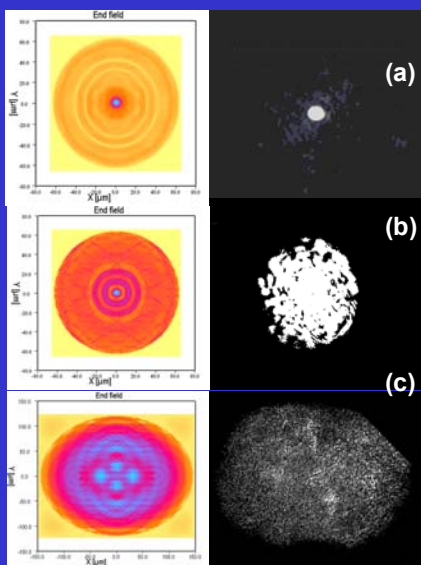


Schematic Drawing of LHPG Station

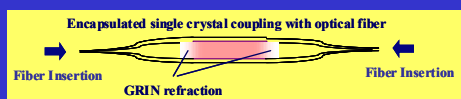
Summary

- Growth of the ferroelectric single crystal fibers of LiNbO₃, both doped and undoped, by the LHPG technique, has been explored with success in obtaining designed orientation (<100>), shape/form (tapered and twisted structures), and dimension (~ 100 μm dia.).
- Simulation of energy and mode propagation property for tapered fiber with acircular cross section was conducted to provide guidelines for parameter design of the tapered fiber.
- Glass encapsulated LiNbO₃ fibers are fabricated with initial success.
- Core-cladding structure and RE-doping distribution, lasing and loss-gain mechanisms are currently under study.

Tapered LiNbO₃ crystal fiber design and modeling

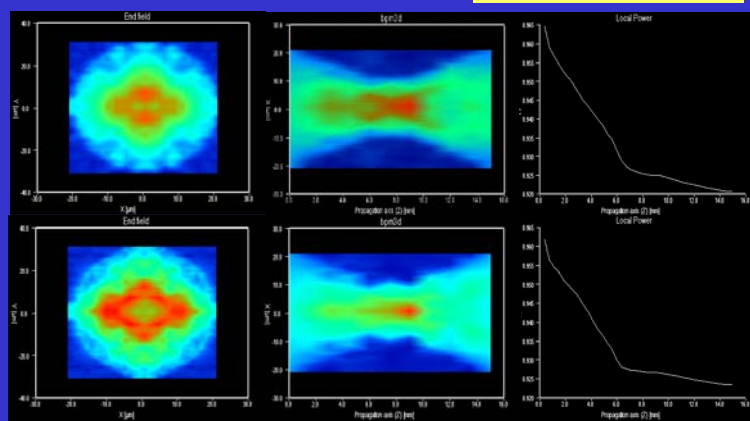
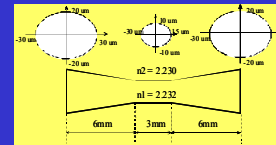


Simulated and experimentally captured intensity profiles for light emerging from (a) single mode, (b) multimode and (c) a-axis LiNbO₃ fiber.



Single Crystal Fiber Encapsulation with Glass Capillary

Two modes with $\Delta n=0.002$ were simulated



Output Field

Light Propagation Along A-Axis

Power Changing Along A-Axis

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