LEHIGH UNIVERSITY

Center for Optical Technologies

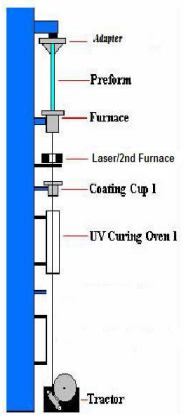
All Optical Network thrust

WAVEGUIDE FABRICATION LABORATORY -

- **Fume Hood:**
  1. Cleaning: Crucible, Die, etc.
  2. Preform/Fiber chemical process
  3. Waveguide Material synthesis: Solid state and wet chemistryl

- **Atmosphere-Controlled Glove Box:**
  1. Air/Moisture sensitive (waveguide) materials synthesis
  2. TeO_2; Chalcogenide, etc.

- **Optical Fiber Drawing Tower:**
  1. Novel glass/polymer fiber drawing
  2. Specialty polymer coating
  3. In-line fiber-modification processes: Laser/Heat/poling treatments, etc.



- **Glass/Ceramics Preparation Facility:**
  1. Melting Furnace
  2. Annealing/Heat Treatment Furnace

RESEARCH AND GOAL -

- **Waveguide fabrication:**
  1. Glass melting
  2 Rod
  3. Tube
  4. Doped tellurite fiber (0.5dB/cm @ 630nm)

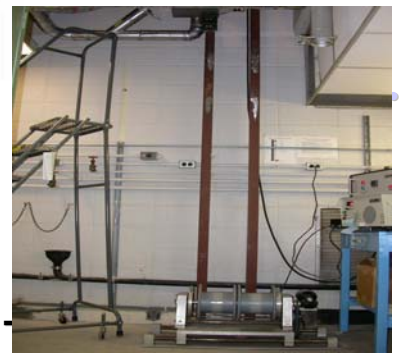
- **Material/Chemistry:**
  FACT But WHY?
  1. Solubility:
     25%$KNbO_3$-TeO_2 VS. 5%$KTaO_3$-TeO_2
  2. 5%$KTaO_3$ glass stability in:
     ZnO-TeO_2 > ZnO-Na_2O-TeO_2 > Na_2O-TeO_2
  3. Unexpected Glass stability:
     $KTaO_3$-ZnO-TeO2 (Tx-Tg=180 ° C) > Na_2O-ZnO-TeO_2 (150 °C)

- **Fiber/Glass modification:**
  1. $KNbO_3$/$LiNbO_3$ doped fiber
     $Sr_{(1-x)}Ba_xNb_2O_6$ doped fiber
     (Other ferroelectric doped fiber)
  2. Thermal/Electrical glass poling
  3. In-line fiber poling
  4. In-line Nano-crystallization
  5. Submicron (Nano-) fiber

- **Structural study:**
  1. Raman:
     Na_2O-ZnO-TeO_2
     Ferroelectric doped TeO_2

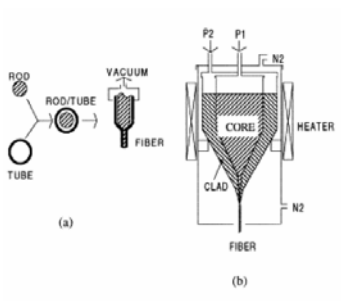
- **Application:**
  1. EO (TeO_2) VS. EO ($LiNbO_3$)
  2. Nonlinearity: Physics & applications

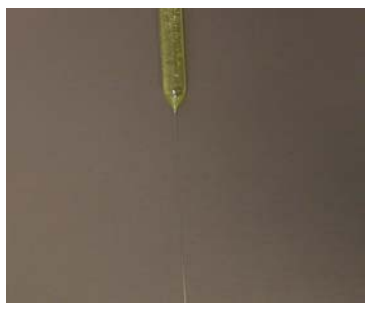
- **Optical characterization:**
  1. Nonlinear optical test: χ^2, χ^3
     $\chi^3(TeO_2) \sim 50 \times \chi^3(SiO_2)$
     Ferroelectric doped effect?
     ATTRIBUTE TO ?
  2. Linear optical constants: n(λ)
     Setup Michelson interferometer

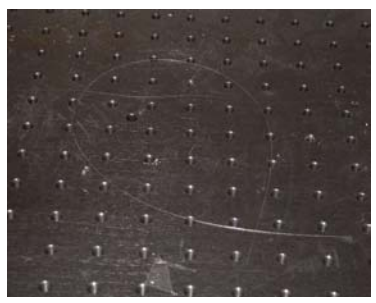


- **General fiber characterization lab setup:**
  1. Loss, Strength, NA, etc.

Fiber Fabrication (Rod-IN-TUBE TECHNIQUE) -







FERROELECTRICS-DISPERSED TeO2 GLASS STABILITY -

Composition (mole)	Tg	Tx1	Tx2	Tm	Tx1-Tg	(Tm-Tx1)/(Tx1-Tg)
10(KNb1/2Ka1/2O3)-90TeO2-1.5KTaO3	342	488		639	146	0.97
10(KNb1/2Ka1/2O3)-90TeO2-0.1Ta2O5	344	512		629	168	1.44
5KTaO3-95TeO2	326	450	538	649	124	0.62
25KNbO3-75TeO2	368	515		619	147	1.41
20ZnO-80TeO2	326	438		631	112	0.58
5Na2O-20ZnO-75TeO2	311	464		571	153	1.43
20ZnO-80TeO2-5KTaO3	340	521		592	181	2.55
5KTaO3-95TeO2-1.5KTaO3	334	455	546	653	121	0.61

FERROELECTRICS-DISPERSED TeO2 GLASS XRD PHASE -

Composition (mole)	Heat Treatment Temp [C]	XRD
25(KNbO3)-75TeO2	320	g
5KTaO3-95TeO2	370	x
15KTaO3-85TeO2	370	x
5Na2O-20ZnO-75TeO2-5KTaO3	320	x
20ZnO-80TeO2	370	g
20ZnO-80TeO2-5KTaO3	320	g
10(KNb1/2Ka1/2O3)-90TeO2-0.3Ta2O5	320	g
5KTaO3-95TeO2-1.5KTaO3	370	x
5KTaO3-95TeO2-1.5KTaO3	420	x
10(KNb1/2Ka1/2O3)-90TeO2-1.5KTaO3	320	x
10(KNb1/2Ka1/2O3)-90TeO2-1.5KTaO3	370	x(g)

NONLINEARITY BY FOUR-WAVE MIXING -

- Intensity $I_s = (\chi^{(3)})^2 \times I_p^3 \times \frac{l^2}{n^4}$
- TeO2 glass ~ 10-50 x SiO2