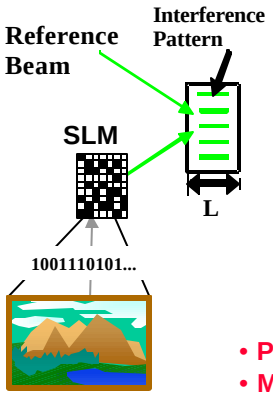
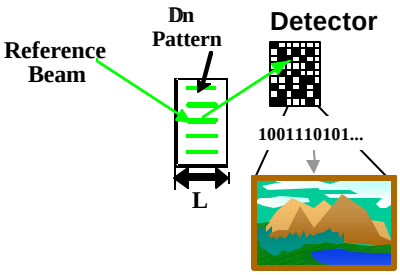
Introduction to Holography

Recording



Readout



- Parallel readout of data - fast rates
- Multiplexing - ultrahigh density

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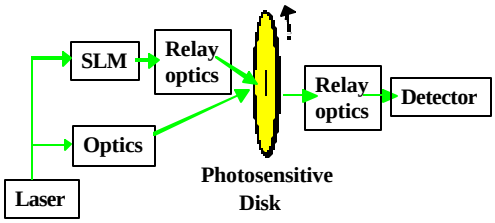
System Goal and Competitive Technologies



Year 2000	Storage Density	Transfer Rates
Holography	120 bits/mm^2	20-60+ MB/s
Magnetic	15 bits/mm^2	10-20 MB/s
DVD	7.5 bits/mm^2	1.5 MB/s
Near-Field	20 bits/mm^2	10-20 MB/s

System Specifications
- ~ Terabit capacity
  - User Data Cap. > 150 GBytes
  - Raw Cap. ~ 320 GBytes
- ~ 100 msec access rate
- ~ 10 MByte/sec write rates
- > 30 MByte/sec read rates

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Requirements for Media for High Density Holographic Data Storage

- Dynamic Range - To support high storage densities & rapid read rates
- Photosensitivity - To support rapid write rates
- Dimensional Stability - To insure high fidelity data recovery
- Optical Quality- To insure high quality imaging of digital data pages
- Media Thickness - To support large numbers of multiplexed holograms
- Visible - Near-IR Light Sensitivity
- Nonvolatile Readout
- Solvent-Free Processing
- Long Archival Life (5-10 years)
- Environmental and Thermal Stability
- Low Cost

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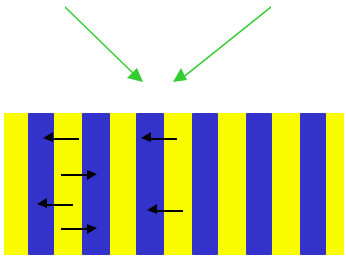
Photopolymer Materials



Holographic recording in photopolymer systems. Local photoinitiated polymerization induces diffusion of the unreacted writing monomer. The resulting compositional gradient establishes a refractive index grating.

- Large Dynamic Range (Δn)
- High Photosensitivity
- Easily Processed
- Permanent (WORM Applications)
- Low Cost

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"Available" Holographic Photopolymer Media

DuPont	Polymeric Binders, Monomers, Plasticizers, Initiating System	• $\Delta n \sim 0.03$ • Thin (< 100 μm) • ~ 5 % change in thickness • Thermal Processing
Polaroid	Polymeric Binders, Monomers, Initiating System	• $\Delta n \sim 0.013$ • Thin (< 200 μm) • Medium is a liquid • ~ 1 % change in thickness

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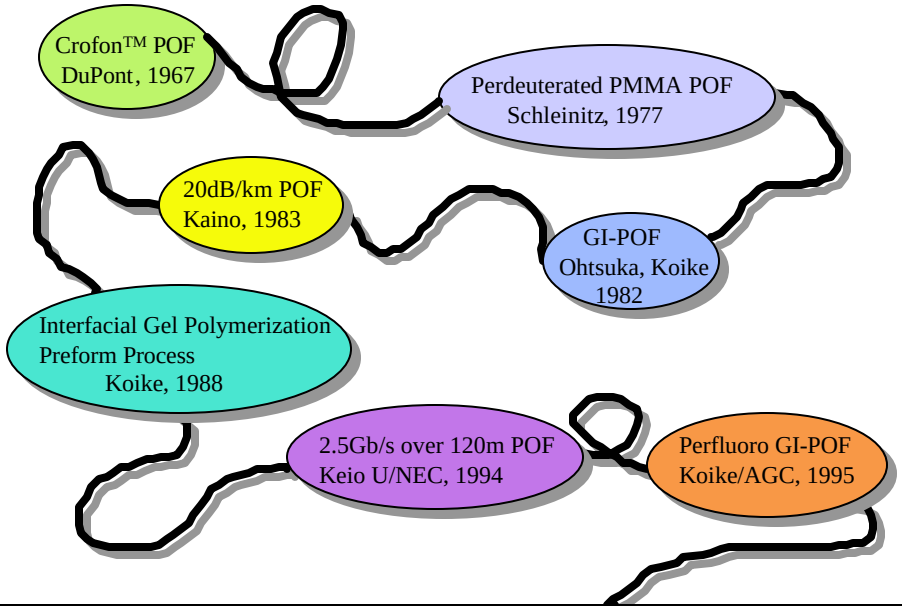
POF HISTORICAL TIMELINE



POF for Telecommunications

Where?

- Premises Networks
- Intrasystem Interconnection
- Home Networks

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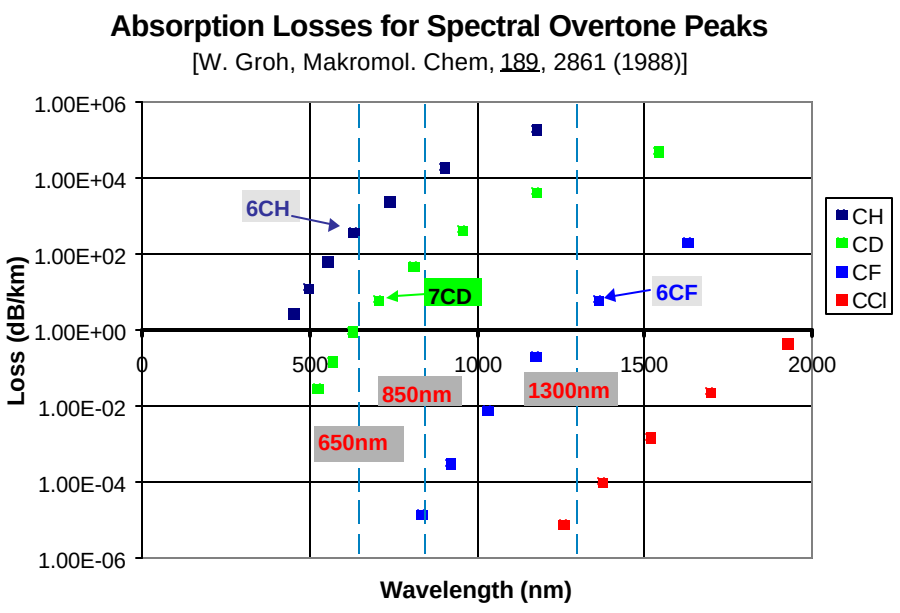
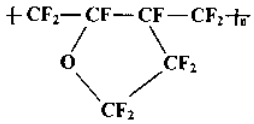
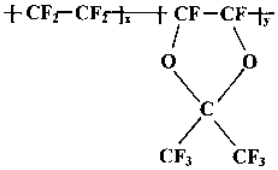


Perfluorinated POF Materials

Amorphous, glassy polymers having no CH bonds





Poly(perfluoro BVE)

n = 1.34, ρ = 2.03
T_g = 108°C

Poly(co-TFE/PDD)

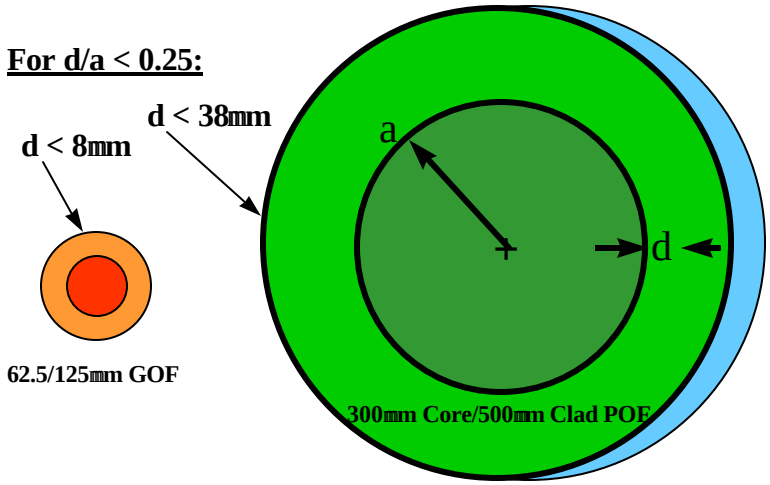
n = 1.31/1.29, ρ = 1.78/1.67
T_g = 160/240°C

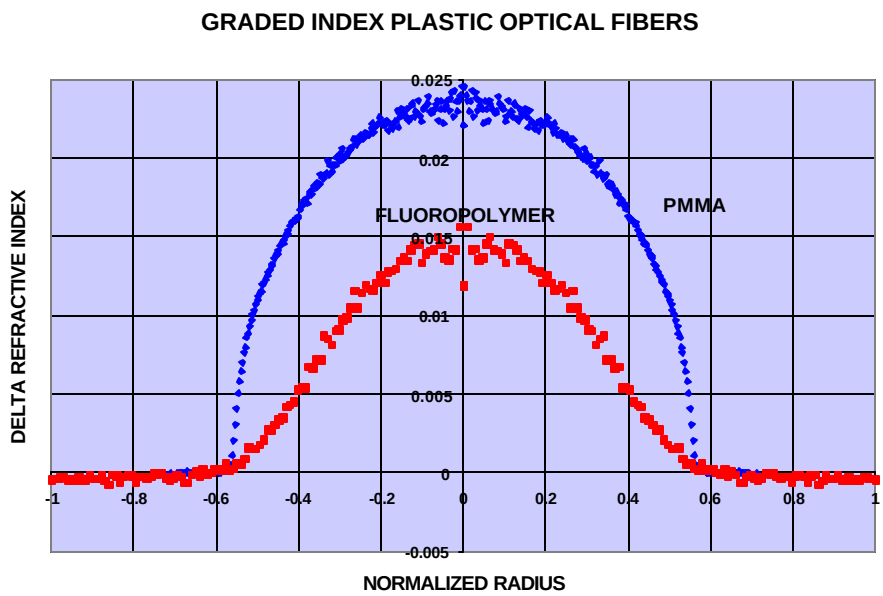
Nonflammable, hydrophobic, very high thermal, oxidative, hydrolytic, chemical stability

Index gradient: Formed by distributing and immobilizing a higher index, organic (non-CH) dopant in the polymer glass.

ALIGNMENT TOLERANCES FOR POF CONNECTOR

For d/a < 0.25:





Challenges for GI-POF - 1

- Promising applications for GI-POF exist
  - Rely on large core diameter
  - Low cost interconnection technologies
  - Material cost must permit large core, large OD
- Perfluorinated GI-POF
  - Dopant selection
    - Intrinsic scattering losses
    - Glass transition behavior
  - Bandwidth
    - Control of profile
    - Mode coupling

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Challenges for GI-POF - 2

- Perfluorinated GI-POF (continued)
  - Long Term Reliability
    - Time-dependent mechanical behavior tractable
    - Thermal stability an advantage
    - Index profile stability: Diffusion kinetics and modeling needed

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