



LE VERRE FLUORÉ
FIBER SOLUTIONS

Fibers for mid-IR transmission

EPIC Meeting on Specialty Optical Fibers,
June 13th, 2024

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The LVF technology: fluoride glasses

High transparency from UV to mid-IR (220 nm – 7000 nm)

ZBLAN (ZFG):

ZrF₄, BaF₂, LaF₃, AlF₃, NaF

InF₃ (IFG)

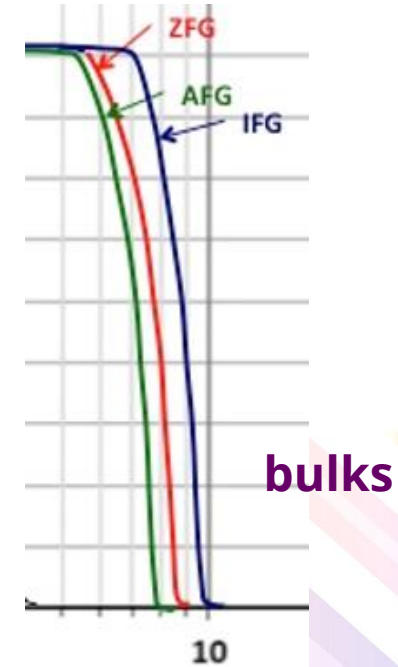
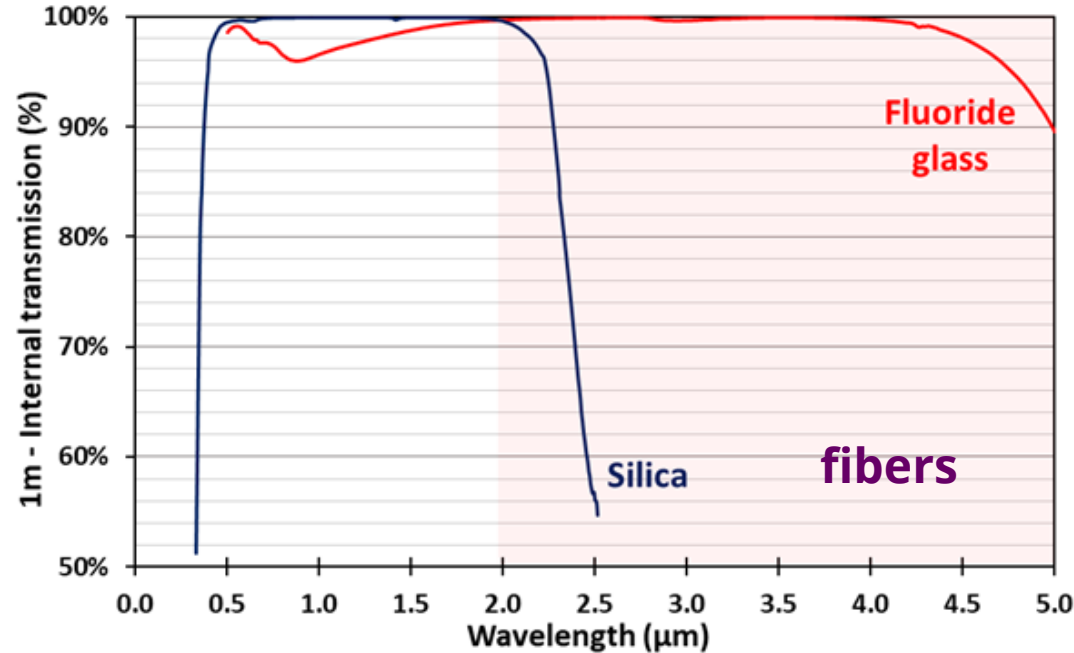
InF₃, GaF₃, PbF₂, ZnF₂,
LaF₃, HfF₄

AlF₃ (AFG)

AlF₃, CaF₂, BaF₂, MgF₂

Germanate (GeG)

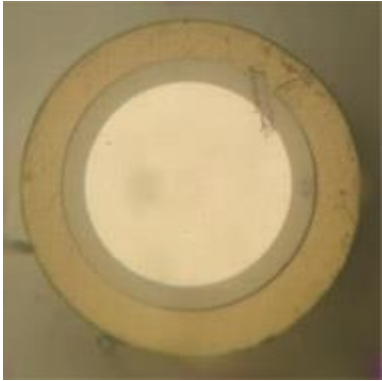
GeO₂, PbO, PbF₂



Many rare-earth transitions for lasers and amplifiers in the visible, the near infrared and the midinfrared (dopants: Dy, Er, Ho, Nd, Pr, Sm, Tm, Yb, ... numerous codopings, at concentration up to 10 mol. %)

Fluoride glass fibers exhibit the best transparency among all technologies in the **2000 nm – 5000 nm** range.

Main fiber designs for transmission



Multimode fiber

$70 \mu\text{m} < \phi_{\text{core}} < 600 \mu\text{m}$

$0.12 < \text{NA} < 0.3$

Transmission from $0.3 \mu\text{m}$ to $5.5 \mu\text{m}$

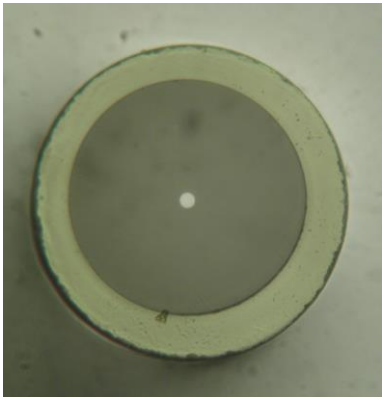


Octagonal fiber

$\phi_{\text{core}} = 100 \mu\text{m}$

$\text{NA} = 0.2$

Mode scrambling fiber designed for $1 \mu\text{m} - 2.4 \mu\text{m}$



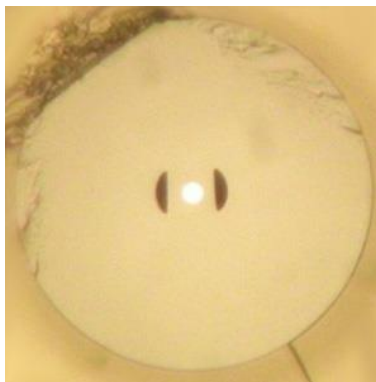
Single mode fiber

Single clad and double clad

$\Phi_{\text{clad}} = 125 \mu\text{m}$ or $250 \mu\text{m}$

$0.06 < \text{NA} < 0.35$

Transmission from $0.3 \mu\text{m}$ to $5.5 \mu\text{m}$



PM fiber




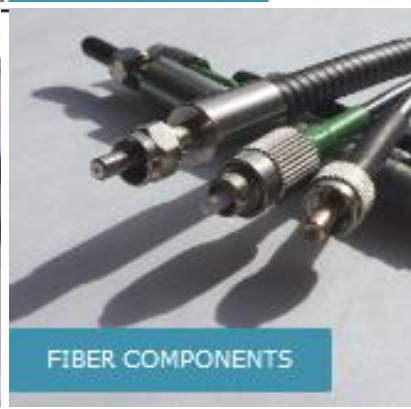

Now : PM fiber for $2 \mu\text{m} - 3.6 \mu\text{m}$ laser transmission

Tomorrow : PM fibers for $2.9 \mu\text{m}$ and $3.2 \mu\text{m}$ PM laser delivery

PM fibers for visible PM laser delivery



5 product lines and their applications

 <p>ACTIVE FIBERS</p>	 <p>FIBER MODULES</p>	<p>Visible, NIR and MIR fiber lasers : medical applications, sensors, material processing</p> <p>MIR supercontinuum laser source : mid-IR spectroscopy, OCT, infrared countermeasures</p>
 <p>PASSIVE FIBERS</p>	 <p>FIBER COMPONENTS</p>	<p>Multimode or singlemode light transmission from UV (300 nm) to Mid-IR (5500 nm) : Industrial spectroscopy, astronomy telescopes coupling, high power laser delivery</p>
 <p>BULK FLUORIDE GLASSES</p>	<p>Undoped or rare-earth doped bulks, prisms and tubes : Visible and mid-IR solid-state lasers, Light conversion (in UV and visible range)</p>	

Main applications of interest for Europe

Medical Applications :

Active fibers or fiber lasers for dermatology and robotic surgery (multiwatts @2.9 μ m)

Sterilized fiber endoscope for robotic surgery

Passive fibers for Er:YAG lasers

Telecom :

Active fibers for fiber amplifiers (O band and S band)

Spectroscopy and imaging :

Active fibers or fiber lasers for visible lasers (red, yellow, green)

Fluorescent glass bulks

Passive fibers for mid-IR spectroscopy (gas sensing and oil&gas)

Mid-IR supercontinuum lasers



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