

# Rare-Earth-Doped Glass Fibre Lasers and Amplifiers

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# Rare-Earth Dopants in Glass

Glass host affects:

- Shape of absorption and emission bands
- Line strengths
- Non-radiative multi-phonon decay rate
- Onset of concentration quenching

## Glasses Investigated

- Phosphates                      Efficient Yb<sup>3+</sup>/Er<sup>3+</sup> energy transfer  
1.3 $\mu$ m Nd<sup>3+</sup> laser
- Fluorophosphates              1.3 $\mu$ m Nd<sup>3+</sup> amplifier
- Lead germanates                Tm<sup>3+</sup> host (intermediate phonon-  
energy)
- Tellurohalides                  Medium phonon-energy
- Chalcogenides )  
Fluorides                      )                      Low phonon-energy
- Lead flints                        Special fibre structures

# TANDEM AND DIRECT (CLADDING) PUMPING OF HIGH-POWER $\text{Er}^{3+}$ FIBRE LASERS AND AMPLIFIERS

DIODE ARRAY	INTERMEDIATE LASER	OUTPUT POWER AT ~ 1540nm
<u>EDFAs</u> 2 x 1W 807nm 3W 807nm 1W 962nm	Nd:YAG (x2) Nd:FIBRE DIRECT	145mW 130mW 55mW
<u><math>\text{Er}^{3+}</math> Lasers</u> 3W 807nm 1W 962nm	Nd:FIBRE DIRECT	270mW 96mW

## GLASSES FOR FIBRE LASERS

DEVICE	DESIRED GLASS PROPERTY	POSSIBILITIES
Long $\lambda$	Low phonon-energy	Fluorides/Chalco's
Upconvertors	Low phonon-energy + blue transmission	Fluorides
Transfer pumped	Tailored phonon energy	Oxides
Doubling/OPO's	High $\chi^{(2)}$	Poled glass

## GLASSES FOR FIBRE/PLANAR DEVICES

DEVICE	DESIRED GLASS PROPERTY	POSSIBILITIES
Fibre switches	High $X^{(3)}$	Chalco's/Tellurites
Bragg gratings	Large photorefractivity	Germanate/Chalco's
UV-written planar waveguides	Large photorefractivity	Germanate/Chalco's
Modulators	High $X^{(2)}$ , $X^{(3)}$ Acousto-optic merit	Chalco's/Poled $\text{SiO}_2$ Chalco's/Tellurites
Planar Amplifiers/ Lasers	High R.E. solubility	Fluorophosphate Processing?

## GLASSES FOR FIBRE AMPLIFIERS

DEVICE	DESIRED GLASS PROPERTY	POSSIBILITIES
1.3 $\mu\text{m}$ Pr <sup>3+</sup>	Low phonon-energy	Fluorides/Chalco's
1.3 $\mu\text{m}$ Nd <sup>3+</sup>	Large branching ratio Shift to shorter $\lambda$	? Fluoro-berylate/ phosphate

## CONCLUSIONS

- Telecommunications amplifiers well established
- Fibre lasers making an impact as single-frequency, widely-tunable, quiet sources
- Ultra-short-pulse soliton generators readily available
- Novel glass hosts important for the development of new laser and amplifier transition, fibre devices