# Toward a high concentration Yb-Er phosphate glass optical amplifier for eye-safe compact LIDAR

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**max. 500 words abstract:**

Light Detection and Ranging (LIDAR) systems offer a powerful remote sensing technique that has been successfully employed for several applications ranging from the detection of obstacles for automobiles and aircrafts, to the topographic investigation of landscapes, and to the detection of wind turbulence and hazardous gases or pollutants.

The key component of a LIDAR system is the laser source whose main parameters, like operating wavelength, pulse width, average and peak power, contributes to overall system performance.

A flexible and advantageous approach to realize a high-power LIDAR source is the Master Oscillator Power Amplifier (MOPA) configuration. The master oscillator produces a highly coherent beam and an optical amplifier (single- or multi-stage) is used to boost the beam output power while preserving its main spectral properties.

The NATO Science for Peace and Security (SPS) project “CALIBER” (CompAct eye-safe Lidar source for AirBorne lasER scanning) aims to develop a compact, lightweight and low-cost version of a LIDAR source that can be placed on small Unmanned Aerial Vehicles (UAVs) or in specific locations of premises where a small footprint equipment is required. The proposed laser source aim to integrate a Semiconductor Saturable Absorber Mirror (SESAM) Q-switched microchip seed laser and a new Er:Yb power amplifier in a compact MOPA configuration, which combines high repetition rate and high peak power at the “eye-safe” wavelength of 1535 nm.

Following the requests of a high degree of compactness while maintaining high performance and low cost, the choice for the optical amplifier fell on an Yb/Er co-doped phosphate glass-based

waveguide. The use of a glass material shows the advantage, over other types of materials, of combining: chemical stability, excellent homogeneity, good thermo-mechanical properties and a viscosity–temperature relationship that allows for shaping the waveguide into the form of optical fibers or rods.

Among the other oxide glass systems, multi-component phosphate glasses are recognized to be an ideal host material for engineering the amplification stage of a pulsed MOPA thanks to their ability to maximize energy extraction and minimize the nonlinearities. They enable extremely high doping levels of rare-earth ions (up to $10^{21}$ ions/cm$^3$) to be incorporated in the glass matrix without clustering, thus allowing the fabrication of compact active devices with high gain per unit length (> 5 dB/cm).

In this work we report on the design and fabrication of a series of Yb/Er-doped phosphate glasses to be used as active materials for the core of a fiber amplifier. The fabricated phosphate glasses were thoroughly characterized in their physical and optical properties and the best composition selected for the fabrication of the first amplifier prototype. Suitable cladding compositions were explored and the final core/cladding glass pair was used to realize a multi-mode optical fiber by preform drawing with the preform being obtained by rod-in-tube technique. Preliminary results of optical amplification are presented for the single-stage MOPA, using a Continuous Wave (CW) source as seed laser.

**max. 300 words abstract:**

LIDAR systems offer a powerful remote sensing technique that has been successfully employed for several applications. The key component of a LIDAR system is the laser source whose main parameters contributes to overall system performance.

An advantageous approach to realize a high-power LIDAR source is the MOPA configuration, in which a master oscillator produces a highly coherent beam and an optical amplifier is used to boost the beam output power while preserving its main spectral properties.

The NATO SPS project “CALIBER” (CompAct eye-safe Lidar source for AirBorne lasER scanning) aims to develop a compact, lightweight and low-cost version of a LIDAR source that can be placed on small UAVs or in specific locations of premises where a small footprint equipment is required.

Following the requests of a high degree of compactness while maintaining high performance and low cost, the choice for the optical amplifier fell on an Yb/Er co-doped phosphate glass-based waveguide. Phosphates are recognized to be an ideal host material for engineering the amplification

stage of a pulsed MOPA thanks to their ability to maximize energy extraction and minimize the nonlinearities. They enable extremely high doping levels of rare-earth ions to be incorporated in the glass matrix without clustering, thus allowing the fabrication of compact active devices with high gain per unit length (> 5 dB/cm).

In this work we report on the design and fabrication of a series of Yb/Er-doped phosphate glasses to be used as active materials for the core of a fiber amplifier. The fabricated glasses were thoroughly characterized and the best composition selected for the fabrication of the first amplifier prototype. Suitable cladding compositions were explored and the final core/cladding glass pair was used to realize a multi-mode optical fiber. Preliminary results of optical amplification are presented using a CW source as seed laser.