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# Temperature-sensitive $Ho^{3+}$ and $Th^{3+}$ longitudinally-shaped optical fibers

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**Abstract:** The temperature response of $Ho^{3+}$, $Tm^{3+}$ longitudinally-shaped optical fibers is analyzed numerically. It re-defines coupled pump and signal propagation equations in such structures in order to introduce different longitudinal shapes of the tapered doped fiber and the temperature dependence of the absorption and emission cross sections of both rare earths.
**Keywords:** Holmium; Thulium; tapers, temperature sensors.
**Topic Code:** Fiber optics, sensors and optical communications

## Introduction

Furthermore, it is key to analyze the temperature response of tapered $Ho^{3+}$ and $Tm^{3+}$ -doped fiber amplifiers in order for such devices to develop more temperature sensitivity of the amplified signal to values comparable to those obtained using other rare earths and different sensing techniques based on tapered, doped fibers.

## Methodology

This is based on the initial assumption that the longitudinally-shaped rare earth-doped section is surrounded by air [1,2]. We then analyze how the energy conversion between the pump and signal radiation is affected by the core-mode fraction within the structure, which implies a selective excitation of the fundamental mode depending on the taper shape. We could study the feasibility and sensitivity of tapered $Ho^{3+}$ and $Tm^{3+}$ -doped fiber amplifier as a sensing element in temperature fiber sensors [3,4]. The proposed testing scheme is shown in Figure 1, which is self-explanatory.

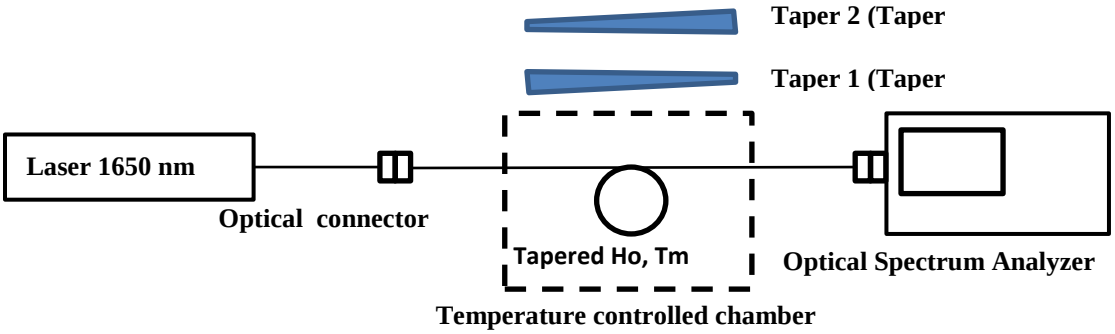


**Fig. 1. - Test Scheme**

## Results

Results shown in Fig.2, for both Ho and Tm show that the temperature sensitivity of the normalized amplified signal was at least 2x10-3/°C for 1W of pump power and 3m or less for the case of Ho, of doped fiber length using a parabolic taper in a co-propagating pump scheme, and this sensitivity can be increased at least 7 times if we adjust the design parameters of the fiber amplifier using fiber lengths lower than 1m and pump powers lower than 150mW.

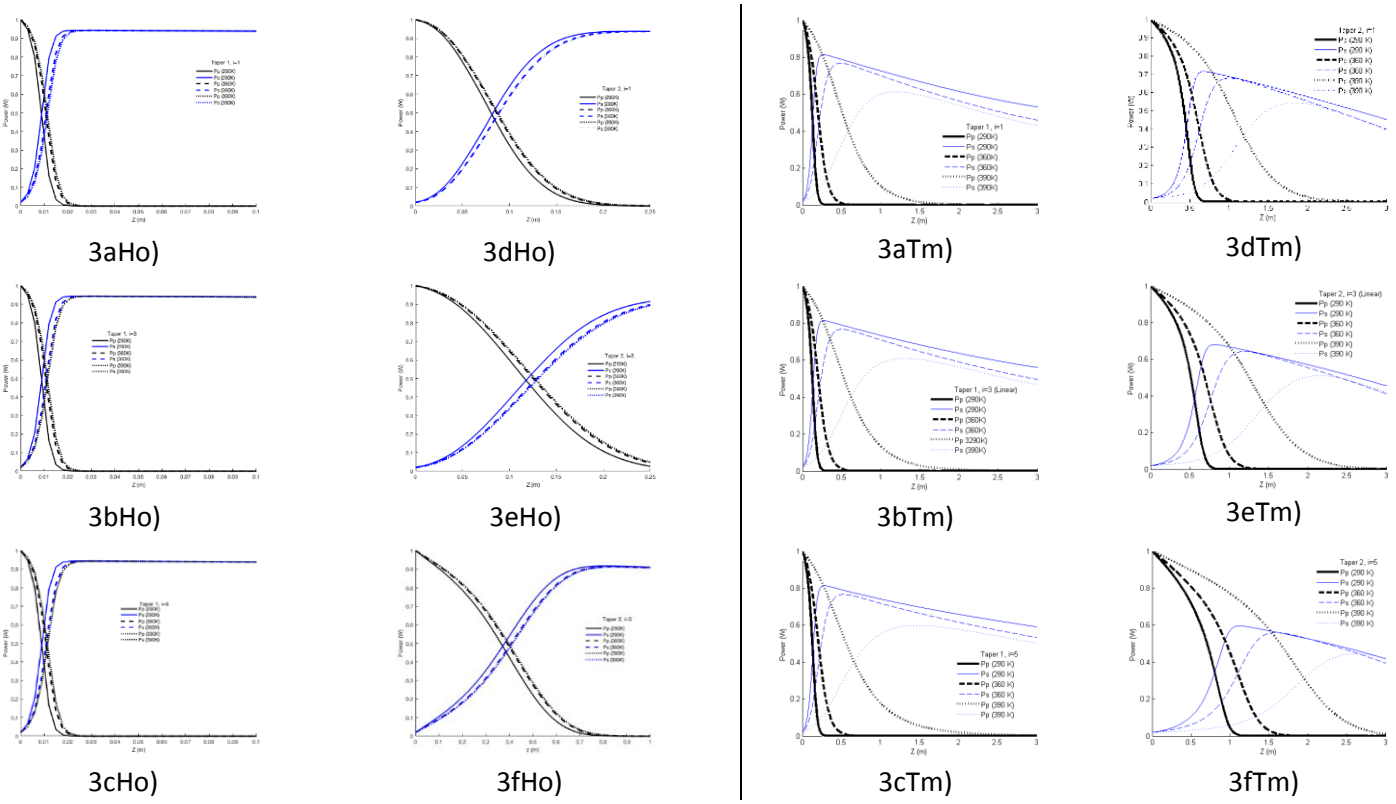


**Fig. 2 Evolution of pump and signal radiations at different temperatures for Ho and Tm fibers**

## Conclusions

We have reported a numerical analysis of the temperature effects in tapered Tm-doped fiber amplifiers in co-propagation mode. We found that the tapering shape and the pump power at the input amplifier modify significantly its temperature sensitivity.

## References

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