

# Efficient Raman Amplifiers for Amplification in Optical Communication Systems

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## INTRODUCTION

Within our modern society we are all continuously requesting more and more capacity in communication systems as for example more and more consumers use the internet in developing countries and as more and more internet services are becoming available. Consequently, research within components for future communications systems have, until this point in time, focused on components that secure the possibility of supporting the request for a continued increases in needed capacity.

An important, optical component is the optical amplifier, and research within the last decade has focused on optical amplifiers that support increased capacity for example Raman amplifiers and fiber optical parametric amplifiers (FOPAs) that may provide gain at a broader range of wavelengths compared to conventional optical amplifiers based on rare-earth-doped fiber materials, and in addition offer an improved noise performance. These improved properties are achieved by neglecting the energy efficiency of the amplifiers. In simple designs only optimized for capacity, the conventional rare-earth-doped fiber amplifiers provide a gain of a few tens of dB for tens of milliwatts of pump power where a Raman amplifier requires watts of pump power to supply a similar gain.

In the future there is an obvious need not only to be concerned about the capacity but also to address the energy efficiency of optical fiber amplifiers. This includes the amplifier configuration as well as the fiber used.

## OUR PROJECT

In this work we focus on the amplifier configuration. We evaluate the quantum efficiency and discuss how close different amplifier configurations are to this limit. We evaluate and discuss the benefit of using a so-called multipass Raman amplifier.

We consider various proposals for the amplifier and optimize the fiber used in the Raman amplifier such that the amplifier requires less energy for the same amplification and without introducing excessive noise. The amplifiers will be simulated in Matlab.

LCA	Materials	Production	Use	Disposal
Materials		x		
Energy			x	

Table 1 Life Cycle Check table for the project.

## REFERENCES

Bromage J. (2004). Raman amplification for fiber communications systems, *Journal of Lightwave Technology*, 22(1), 79-93.