Efficient Raman Amplifiers and Fibers 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. This is for example due to increased internet traffic where more and more consumers use the internet in developing countries and in addition more and more 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 increase 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 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. This is achieved by neglecting the energy efficiency of the amplifiers. In simple designs optimized for capacity, the conventional rare-earth-doped fiber amplifiers provide a gain of a few tens of dB for tens of mW of pump power where a Raman amplifier requires watts of pump power to supply a similar gain. One reason for this is that only a fraction of the pump power is used because for low pump power the noise performance in general is degraded, unless novel amplifier configurations are developed.

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 two important fiber parameters are the Raman gain coefficient and the loss. In general, the higher Raman gain coefficient the better, however materials with a large Raman gain coefficient have a large loss. We will evaluate the energy efficiency of different commercial fibers and discuss optimized fiber designs. The amplifiers will be simulated in Matlab.

LCA	Materials	Production	Use	Disposal
Materials		x		
Energy			x	
Chemistry				
Other				

Table 1 Life Cycle Check table for the project.