NÉEL INSTITUTE Grenoble
PhD grant

Quantum memory integration of rare-earth doped crystals

Context :
Rare-earth ions because of their unique 4f electronic configuration form well isolated systems when embedded in solids. They have long coherence time at low temperature making them highly promising qubits for the development of quantum technologies: as solids, they offer perspectives of integration, while keeping atomic properties (narrow lines) when interacting with light (optical or RF). Erbium is particularly appealing in this prospect because its optical transition falls in the telecom range, and can naturally be used as a support for optical quantum memories and more generally as a fast and versatile element of control on the qubit.

Objectives :
The main objective is to integrate erbium doped materials into a photonic platform and perform a demonstration of quantum storage using this device. Most of the realizations have involved so far bulk crystals, namely oxides compounds containing yttrium. As compared to glass, silicon or lithium niobate, rare-earth activated samples are not commercially available as a photonic platform. Based on a recognized national consortium (see below), we propose firstly to fabricate elementary wafer supporting rare-earth doped crystals. After a secondary integration/fabrication step to produce a waveguide, we will benefit from the light confinement to enhance the interaction. We therefore propose to perform a quantum memory demonstration using this unique device.
The thesis covers the different steps of the project, going from fabrication processes (polishing and surface adhesion), mechanical characterization of the samples at cryogenic temperatures, elementary spectroscopy of the ions embedded in the structure to identify the local strain, advanced spectroscopy (photon-echo) to evaluate the enhanced light-matter interaction by the waveguide structure, to the final implementation of memory protocols using the fabricated device.

Collaboration and networking :
- Institut de Microélectronique Electromagnétisme et Photonique et le LAboratoire d'Hyperfréquences et de Caractérisation (IMEP-LAHC)
- Institut de Physique de Nice
- Institut de Recherche de Chimie Paris
- Laboratoire Kastler Brossel

Required profile:
Experimental skills in one the domains are highly recommended : optics, laser, atomic spectroscopy.
General interest in the optimization of fabrication processes would be appreciated.
Education background in quantum physics and general optics, non-linear optics or light-matter interaction is demanded.

Starting date : Fourth Quarter 2022
Duration : 36 months

Contact :
Name : Thierry Chanelière
Institut Néel - CNRS
Phone : 04 76 88 10 07 e-mail : thierry.chaneliere@neel.cnrs.fr
More information : http://neel.cnrs.fr