DESCRIPTION FOR THE GENERAL PUBLIC

Today, semiconductor lasers are used in many areas of life: telecommunication, printers, CDs, DVDs and Blu-ray drives, but also in in medicine, defense, or environmental protection. Many of these applications require devices with very high quality: in particular it is much desired to have large emitted power and so-called single-mode operation, in which laser emits only a single desired wavelenght. Unfortunately, in modern surface emission lasers these two requirements are very difficult to reconcile. To do so, research laboratories around the world are working on complex structures called ARROW that placed in the vicinity of the surface of the laser allow to focus the desired mode (i.e. the desired wavelength) and to scatter all the others. However, in all lasers the light is generated inside of the so-called resonant cavity, and hence, the effectiveness of these structures is limited. Placing them inside the resonant cavity should improve their effectiveness, although, it is very difficult to achieve technologically. However, there are laboratories that are able to do so. In particular, the team from LAAS-CNRS laboratory in Toulouse, France, has the capability to create such structures by selective oxidation of chosen areas within the resonant cavity.

The aim of this project is to carefully examine how such structures will affect the operation of surface emitting lasers. We want to do this using advanced computer simulations. Through accurate representation of the laser construction in computer memory and the solution of equations describing physical phenomena (e.g. heat and current flow inside the device or light diffration), we can predict the output characteristics of the device. Since we do not need to manufacture real prototypes, we may cheaply examine the wide variety of constructions and see how the differences between them affect their behavior. Furthermore, we can—using methods of computer optimization—find such parameters of investigated lasers that ensure their best quality. This will help us in future developement of high-end devices for applications stated in the beginning.

Of course, the results of computer simulations may be correct only if the input data is right. Some part of this data is well known, while to other part must be somehow established. We can do this with the help of LAAS-CNRS laboratory which has declared that it will manufacture the devices based on our desings. By measuring multiple parameters of these devices and comparing them with the values obtained in the computer simulations, we will be able to determine the correctness of our calculations and the correct values for the input data. As a result, we will become much more confident that our further simulation results will apply to the realistic devices.

Finally, by completing this project, we will get a much deeper understanding of the impact of ARROW structures located deep inside the resonant cavity on surface emitting lasers. Furthermore, we will be able to designs high-end surface emitting lasers that will provide both high output power and desired single-mode operation.