Metallic Photonic Band Gap Structures for Laser Applications

F. H'Dhili[1,2], **T. Okamoto**[1], **J. Simonen** [1,3], **and S. Kawata** [1,4]

[1]RIKEN Nanophotonics Laboratory, Japan
[2]Tunis El Manar University, Tunisia
[3] University of Joensuu, Finland
[4]Osaka University, Japan

We report on a two dimensional plasmonic crystal laser structure that utilizes a thin Ag film for the generation of long range surface plasmons (LRSPs) and a layer of the organic semiconductor tri(8-hydroxyquinoline) aluminum (Alq3) doped with the laser dye 4-dicyanmethylene-2-methyl-6-(p-dimethylaminostyryl)-4H-pyran (DCM) as active medium. The dispersion diagram of this structure exhibits a plasmonic bandgap in the dye emission wavelength range. At the flat bandedge, the groupe velocity tends to zero, so that the density of surface plasmon modes is high. This yields a lasing action. However, the device suffers from the energy dissipation (metal absorption, unwanted radiation, etc.). We suggest few ways to minimize the effect of this problem. First, we propose the use of LRSPs characterized by a low loss coefficient. To this end, we investigate theoretically and experimentally the best conditions for the excitation of these modes. A strong emission is observed compared to that from a planar structure. These modes provide a high performance when the dye thickness is about 100 nm, a value consistent with the numerical findings. In addition, we demonstrate that the use of a spacer layer significantly increases the emission efficiency. We further suggest a new design for the laser structure for minimal radiation loss.