Supermodes in nanophotonics

Optical cavities are characterized by the storage of electromagnetic energy in the form of optical modes. These optical modes define the performance of cavities in various applications, such as lasers, switches and sensors. Losses of electromagnetic energy from the cavity are characterized by the quality (Q-)factor of the cavity, which provides the number of optical cycles that can be stored before the energy is lost. The Q-factor defines the life-time of the optical mode, its spectral line width and the ultimate performance of the cavity. The losses can be of two kinds: electromagnetic absorption by the materials forming the cavity or radiation leakage from the cavity.

A careful design of the cavity structure can lead to the full suppression of the radiation leakage from the cavity by destructive interference of the scattered electromagnetic fields. If the cavity is made of non-absorbing dielectrics, the absorption losses can be also suppressed. In this situation, surpermodes with an infinite life-time and an infinitely narrow line width (infinite Q-factor) are formed. These supermodes can be used to reduce the threshold of optically pumped lasers, or to increase the sensitivity of optical sensors.

In this project, you will investigate the properties of supermodes in nanocavities formed by non-absorbing nanoparticles. These supermodes will be used to reduce the threshold of organic nanolasers. Skills that you will acquire during the project are: Modelling cavity modes in nanophotonic cavities, working with (ultra-fast) laser systems, performing high precision optical measurements, analyzing these measurements to obtain information such as Q-factor, mode life-time, lasing threshold, spatial and temporal coherence, beaming, etc.

If you are interested in this project, please contact Prof. Jaime Gomez Rivas (j.gomez.rivas@tue.nl).

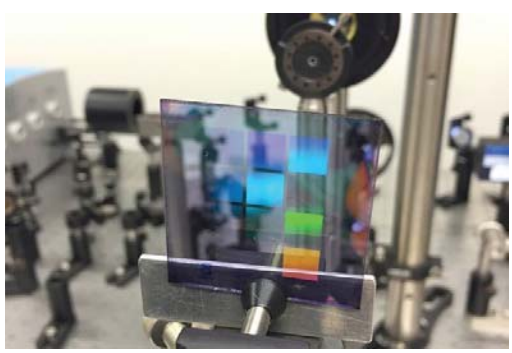

Figure: photograph of arrays of nanolasers emitting at different wavelengths