Slow light enhancement and limitations in periodic media - DTU Orbit (17/10/2019)

**Slow light enhancement and limitations in periodic media**

Properties of periodic dielectric media have attracted a big interest in the last two decades due to numerous exciting physical phenomena that cannot occur in homogeneous media. Due to their strong dispersive properties, the speed of light can be significantly slowed down in periodic structures. When light velocity is much smaller than the speed of light in a vacuum, we describe this phenomena as slow light. In this thesis, we analyze important properties of slow light enhancement and limitations in periodic structures. We analyze quantitatively and qualitatively different technologies and significant structures with numerical and analytical methods. By analyzing different structures, we show very general properties for limitation and enhancement in the slow light regime.

Inherent imperfections of fabricated structures such as a material loss and structural disorder have a strong influence on slowly propagating light. By means of perturbative analysis, we address the effect of small imperfections in periodic structures. From our analysis, we find very universal behavior in a slow light regime for all periodic structures. Even if losses are very small the dispersion is severely affected in the vicinity of the band edge. The minimum attainable group velocity will depend on the amount of imperfections. Since imperfections are inherited as part of any periodic structure it is necessary to take them into account when we are interested in slow light applications. Slowly propagating light gives rise to longer interaction time in the periodic media. Due to this reason, weak light-matter interaction is enhanced. The enhancement due to slow light has been studied for loss and gain. By introducing gain/loss, dispersive properties, in the slow light region, are severely influenced. The minimum attainable group velocity is strongly dependent on the amount of introduced loss/gain that will result in limitation of enhancement. Therefore, small amounts of gain/loss will provide great enhancement. While for a large amount of gain/loss slow, light is heavily jeopardized, hence no enhancement will occur.

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