Plasmonic enhanced EIT and velocity selective optical pumping measurements with atomic vapor

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Abstract:

In this work, we experimentally observe for the first time nanoscale plasmonic enhanced Electromagnetically Induced Transparency (EIT) and Velocity Selective Optical Pumping (VSOP) effects in miniaturized Integrated Quantum Plasmonic Device (IQPD) for D_2 transitions in Rubidium (Rb). Our device consists of a vapor cell integrated on top of a prism coated with a thin layer of metal. This configuration is known to allow efficient excitation of Surface Plasmon Resonance (SPR). The evanescent field of the surface plasmon mode interacts with the atomic media in close vicinity to the metal. In spite of the limited interaction length between SPR and Rb atoms, the signature of EIT along with VSOP signals could be clearly observed in our miniaturized IQPD under proper conditions of pump and probe intensities. A gradual decrease in the contrast of the plasmonic enhanced EIT and VSOP signals was observed as the excitation was detuned from the SPR critical angle, due to reduction in electromagnetic field enhancement, leading to a reduced interaction of the evanescent field with the atomic vapor media. Following the demonstration of these effects, we also present a detailed model revealing the mechanisms and the origin of plasmonic enhanced EIT and VSOP effects in our system. The model, which is based on the Bloch equations, is in good agreement with the observed experimental results. The obtained results are regarded as an additional step in the quest for the realization of nanoscale quantum plasmonic effects and devices.