Suppression of Optical Losses in Noble Metals within the Visible Frequency Range

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Noble metals such as gold and silver demonstrate exotic optical properties and have been extensively used in optical metamaterials. Unfortunately, these materials introduce high losses in the optical spectrum, which considerably restrict many applications of metamaterials where the required figure of merit needs to be very high. Several studies, both theoretical and experimental, have been conducted to suppress the optical losses. Examples include gain media, parametric second harmonic generation, and quantum optics approach. Nevertheless, the majority of this research is restricted to theoretical models or can be considered as optical laser-like amplifier more than an optical loss suppressor. Recently, a novel method has been introduced to reduce the optical losses in noble metals as well as in semiconductors. The technique is known as the parametric two-wave coherent coupling. The mechanism is based on the standard formalism of Boltzmann equation, and takes into account the wave coupling through the carriers in conduction band. The theoretical and analytical study of the mechanism has already been published, and the experimental proof of the mechanism in the Mid-IR frequency range has been reported as well. In the current work, the parametric two-wave coherent coupling technique consists of a support wave which is provided by a Nd-YAG laser at 1.064 μm, and the probe wave at 0.532 μm which is generated from the non-linear optical crystal Potassium Titanyl Phosphate (KTP) by means of the second harmonic generation technique. By adjusting the phase shift between the probe and support waves, and their amplitudes, the optical losses can be significantly suppressed. In this presentation, both the theoretical and experimental results for the reduction in losses in noble metals within the visible frequency range will be presented.