Optical Breather in Phosphorene Monolayer

Authors : Guram Adamashvili

Abstract : Surface plasmon polariton is a surface optical wave which undergoes a strong enhancement and spatial confinement of its wave amplitude near an interface of two-dimensional layered structures. Phosphorene (single-layer black phosphorus) and other two-dimensional anisotropic phosphorene-like materials are recognized as promising materials for potential future applications of surface plasmon polariton. A theory of an optical breather of self-induced transparency for surface plasmon polariton propagating in monolayer or few-layer phosphorene is developed. A theory of an optical soliton of self-induced transparency for surface plasmon polariton propagating in monolayer or few-layer phosphorene have been investigated earlier Starting from the optical nonlinear wave equation for surface TM-modes interacting with a two-dimensional layer of atomic systems or semiconductor quantum dots and a phosphorene monolayer (or other two-dimensional anisotropic material), we have obtained the evolution equations for the electric field of the breather. In this case, one finds that the evolution of these pulses become described by the damped Bloch-Maxwell equations. For surface plasmon polariton fields, breathers are found to occur. Explicit relations of the dependence of breathers on the local media, phosphorene anisotropic conductivity, transition layer properties and transverse structures of the SPP, are obtained and will be given. It is shown that the phosphorene conductivity reduces exponentially the amplitude of the surface breather of SIT in the process of propagation. The direction of propagation corresponding to the maximum and minimum damping of the amplitude are assigned along the armchair and zigzag directions of black phosphorus nano-film, respectively. The most rapid damping of the intensity occurs when the polarization of breather is along the armchair direction.

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