53
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Title:Terahertz plasmon amplification using two-dimensional electron-gas layers
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Abstract:In this study, we present an analytical model to investigate the possibility of guiding and amplifying terahertz (THz) plasmons in a two dimensional electron gas (2DEG) layer of a hetero-structure by applying a bias electric field. This analytical model solves Maxwell equations and semi-classical electronic transport equations inside the biased hetero-structure simultaneously. It is shown that the two dimensional plasmon's properties alter vastly as the electrons are accelerated by the bias field. Four asymmetric plasmonic modes can propagate inside the un-gated 2DEG layer of the biased hetero-structure. One of these modes in the un-gated 2DEG layer is a growing mode which can be useful in the implementation of THz amplifiers. Since the modes characteristics can be controlled via biasing, design of new plasmonic devices such as modulators and switches is possible by this approach. Similar analysis has been performed in a gated 2DEG layer that shows clear changes in the two dimensional plasmon properties due to the biasing. Unlike the un-gated 2DEG layer, our efforts to find a growing mode in the gated 2DEG layer have failed. These multi-physics models lead to a better understanding of THz plasmonic sources and detectors as well as proposals on new plasmonic devices. Besides, they provide a physical insight into the electron-wave interactions inside the biased hetero-structure. © 2012 American Institute of Physics.
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