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Multiphysics modeling of non-linear laser-matter interactions for optically active semiconductors[1] BRENT KRACZEK, JAROSLAW KANP, US Army Research Laboratory — Development of photonic devices for sensors and communications devices has been significantly enhanced by computational modeling. We present a new computational method for modelling laser propagation in optically-active semiconductors within the paraxial wave approximation (PWA). Light propagation is modeled using the Streamline-upwind/Petrov-Galerkin finite element method (FEM). Material response enters through the non-linear polarization, which serves as the right-hand side of the FEM calculation. Maxwell's equations for classical light propagation within the PWA can be written solely in terms of the electric field, producing a wave equation that is a form of the advection-diffusion-reaction equations (ADREs). This allows adaptation of the computational machinery developed for solving ADREs in fluid dynamics to light-propagation modeling. The non-linear polarization is incorporated using a flexible framework to enable the use of multiple methods for carrier-carrier interactions (e.g. relaxation-time-based or Monte Carlo) to enter through the non-linear polarization, as appropriate to the material type. We demonstrate using a simple carrier-carrier model approximating the response of GaN.

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