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We investigate a new class of graded-index metamaterial with the effective dielectric permittivity and magnetic permeability gradually changing from positive to negative values, referred to as transition metamaterials. In this talk we discuss our current research focused on several peculiar optical phenomena taking place in such transition metamaterials, including anomalous electromagnetic field enhancement and resonant absorption and their potential applications for linear and especially nonlinear optics. We will also discuss an entirely new regime of nonlinear optical light propagation in guided wave structures ” couplers made of positive and negative index metamaterials. Oppositely directed phase and energy velocities in a negative index channel enable such nonlinear optical phenomena as optical bistability, gap solitons, self-oscillations, and novel regimes of modulation instability in these couplers. These effects have no analogies in conventional nonlinear directional couplers with no external feedback mechanism, and thus open new opportunities for the development of optical storage and logic applications. (Received February 23, 2010)