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Photonic Integrated Circuits Based on Plasmonics and Quantum Dot Materials: Properties, Compensation of Optical Losses and Applications

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Nanophotonics and plasmonics have received much attention recently, fuelled by a general interest in nanotechnology but also by rapid advances in integrated photonics, mainly brought about by using silicon, with larger refractive index difference than previously employed [L. Thylen et al, J. Zhejiang Univ. SCIENCE 2006 7(12)]. Plasmonics offers a possibility for devices with field sizes much smaller than the wavelength of light in aa host medium. But the tighter the field confinement, the greater are generally the optical losses, determined by the imaginary part of epsilon. This remains a critical issue. Dissipative losses impede the ubiquitous usefulness of nanophotonics light wave circuits. Recently, optical gain in quantum dots for reducing or compensate losses was analyzed [A Bratkovsky et al, Applied Physics Letters 93, 193106 (2008)]. However, the concomitant effects of the high (but not unreachable) gain required for this are *high* power *dissipation* and *signal to noise ratio degradation*. Power dissipation is primarily due to the losses of the metal structures and Auger recombination in the quantum dots. A general and square chip size independent expression for the information capacity of a lossless (by amplification) plasmonic chip is given, using the allowed values for integrated electronics power dissipation. In conclusion, with amplification and with current understanding, it appears possible to sizewise come close to CMOS dimensions for isolated integrated photonic devices, but not in integration density. This is due to power dissipation in currently employed negative epsilon materials.