Nanostructuring of materials for photonics with designer ultrafast laser pulses

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The capability to restrict energy deposition is key in designing accurate laser processing technologies and in fostering progress in laser-based micro/nano-technologies. Optical resolution being limited by diffraction, new methods are required to harvest either near-field effects or to build up on material reactions, restricting the processing scale well below the diffraction limit. This excitation confinement, along with the nonlinearity of the interaction between ultrashort laser pulses and dielectric materials, is at the base of refractive index engineering and forms the building block for developing volume embedded optical functions. We will explore the potential of designing the beams in space and time to achieve interaction control and high resolution in three dimensions and to fabricate complex hybrid micro-nano optical systems, capable of transporting, manipulating and accessing optical signals. We indicate a range of applications, from telecom to astrophotonics, including applications designed for the mid-IR spectral range for sensing and imaging.