Novel Aspects of Materials Processing by Ultrafast Lasers: From Optical to Biological and Cultural Heritage Applications

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Materials processing by ultrafast lasers offers several unique possibilities for micro/nano scale applications. This is due to the unique characteristics of the laser-matter interactions involved, when sub-picosecond pulses are employed. These include the reduction of undesirable thermal and photochemical effects, minimization of heat diffusion thereby enabling the processing of sensitive materials (e.g. organic molecular substrates), the ejection of directional and energetic particles, which favours low temperature thin film growth. Further advantages stem from the possibility of producing phase tailored pulses for control and process optimization [1].

Prospects and limitations of femtosecond laser technology will be discussed in the context of surface and in bulk induced modifications. In particular, examples of diverse applications including the development of polarization controllable photonic devices [2], the direct microprinting of biological materials [3], the laser based control of actuators based on photochromic molecules [4] and the laser cleaning of delicate artworks will be presented. Emphasis will be placed on the induced chemical modifications, since these are crucial for the potential of femtosecond laser processing of molecular substrates, such as biomaterials or painted artworks. The results indicate that in femtosecond laser processing of organic materials, besides the well acknowledged morphological advantages, a second fundamental factor responsible for the success pertains to the selective chemical effects [5].

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