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Femtosecond Generation of Nano-Fibers

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Abstract

A new approach to making extremely large aspect ratio glass nano-fibers with diameters typically 20- 40 nm is described. The fabrication process utilizes a novel phenomenon occurring with the interaction of focused high power femtosecond laser radiation with transparent media.

Summary

Femtosecond bulk modification of transparent dielectrics has been established for more then a decade now [1,2]. The modification of the material properties is thereby often explained by non-thermal events such as E'-center formation or bond reordering occurring in the focal volume [3,4].

Melting in dielectrics on a femtosecond time scale due to ultrashort laser pulse radiation however is also been established for the high repetition rate irradiation regime [5,6]. It occurs if the repetition rate is increased significantly to the point, at which the energy input from adjacent pulses start to interact with each other. An alternative absorption scheme beside multi-photon absorption was suggested in the high repetition rate case [7]. Recently it has been reported that the thermal accumulation effect combined with the induced pressure in the focal volume due to thermal expansion can result in surface features such as the formation of nano-fibers [8]. The driving physical mechanisms of the fiber formation process are not fully understood.

In this paper we will present the results of our research regarding the nano-fiber formation process. Several materials have been investigated for the occurrence of nano-fiber formation. A comprehensive model of the thermal dynamics within the irradiated volume will be presented, comparing non-linear absorption as establish energy absorption

process with possible linear-like absorption in the heated volume by free electron heating. The nano-fiber properties were characterized as a function of the irradiation conditions.

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