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The influence of beam-cone-angle on the high energy laser induced damage of optical thin film

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A continuous Wave (CW) laser beam with extremely high power density is needed in the experimental study of the optical film's thermal damage. In order to achieve such high power density, the incident beam generally needs to converge. In this situation, the cone-angle of the converged beam is inevitable, which may affect the heat distribution in the optical film and make much difference on the thermal damage process. A physical model is established to study the influence of the beam cone angle on the thermal damage of the optical film. A thin-film Fabry-Perot filter is taken as a calculation example, which is composed of two film materials: HfO_2 (marked as H, $\lambda/4$) and SiO_2 (marked as L, $\lambda/4$). The stack formula of the film is assumed as $(HL)^8(LH)^8L$. The temperature climbs very fast when the film is irradiated by parallel beam. In 10s, the temperature of the film reaches ~ 2200 K. It means that the film will be totally damaged in 10 s. If the cone's half angle is 6° , the film's temperature increases relatively slow. The temperature only grows to ~ 1080 K. The film may still work well on this temperature. In a word, the cone-angle of the beam has serious influence on the damage of optical thin film. Large cone-angle considerably reduces the temperature increment of the optical thin film. The cone-angle changes the laser intensity distribution in the multilayer film. Consequently, the temperature distribution and the temperature rising process are also related to the cone-angle. Only if the cone's half angle is smaller than 2° , the influence of the cone-angle can be ignored. In the case that the cone's half angle is larger than 6° , the film's damage induced by converged beam is totally different from the damage induced by parallel beam.

Biography

Han Kai has received his Bachelor's degree in Optical Information Science and Technology and PhD degree in Optical Engineering from National University of Defense Technology. Since 2013, he has served at College of Advanced Interdisciplinary Studies, National University of Defense Technology. Currently, he is an Assistant Professor working on laser technology. His research interests include various aspects of fiber laser, coherent beam combination and laser induced damage. He is the author of over 20 papers published in various scientific journals and conference proceedings. He is the Reviewer of the *Journal of Optics Letters*, *Journal of Modern Optics*, etc. He is also the Editorial Board Member of the *Journal of Opto-Electronic Engineering*.

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