Exploring parameter space for cold ablation in thin polymer film using femtosecond laser pulses

Arnas Vyšniauskas[1,2*], Evaldas Kažukauskas[1,3], Valdemar Stankevič[1,2], Paulius Gečys[1]

[1] Center for physical sciences and technology (FTMC), Savanoriu Ave. 231, LT-02300, Vilnius, Lithuania
[2] Akoneer, Ltd, Mokslininku 6B, LT-08412, Vilnius, Lithuania
[3] 3Laser Research Center, Faculty of Physics, Vilnius University, Sauletekio Ave. 10, LT-10223 Vilnius, Lithuania
*Corresponding author email: arnas.vysniauskas@ftmc.lt

In this work, we explore how femtosecond laser pulses can be optimized to achieve efficient and thermally unaffected ("cold") cutting of thin polymer films. Since polymers tends to be heat-sensitive, traditional laser cutting methods can cause unwanted thermal damage. Ultrashort laser pulses potentially offer cleaner, more precise cutting by significantly reducing the formation of heat-affected zones (HAZ). Our experiments systematically vary parameters such as laser repetition rate, energy fluence, scanning speed and pulse overlap to determine their impact on cut quality and efficiency. Initial results indicate certain parameter combinations drastically reduce thermal effects, preserving the integrity of the material. Conversely, straying from these parameters increases heat accumulation and reduces cut quality. Additionally, we found that cutting efficiency correlates closely with energy fluence and pulse overlap, highlighting that minimal thermal diffusion is critical for achieving optimal results. These findings provide practical guidelines for improving precision and efficiency in femtosecond laser processing of polymer films.

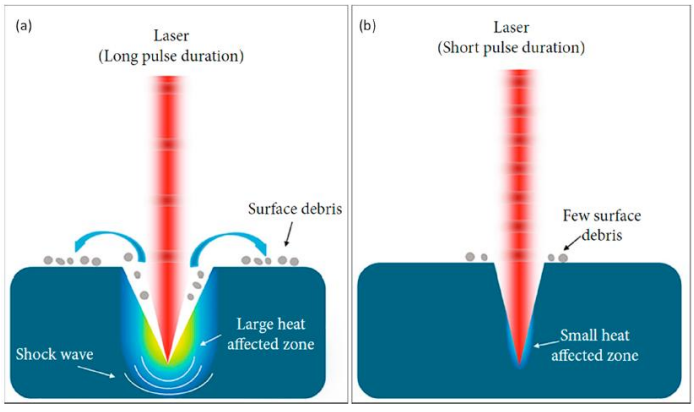

Figure 1. Laser and material interaction characteristics with (a) long pulse and (b) short pulse, adapted from [1].

References:

[1] Lin, Z.; Hong, M. Femtosecond laser precision engineering: From micron, submicron, to nanoscale. Ultrafast Sci. 2021.