如何让液体纳秒激光烧蚀效率更高

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在催化和生物医学等领域，液相激光烧蚀（Laser ablation in liquid, LAL）是一种广泛应用的纳米材料制备方法，可用于生产无配体胶体。与化学合成的胶体相比，LAL 生成的颗粒具有更高的信噪比。它们既适合作为纳米级毒理学检测的参比材料，也可用于 3D 打印的微粒级修饰，另外在多相催化领域也具有巨大的潜力。

德国慕尼黑应用科学大学的 Heinz Huber 教授和伍珀塔尔大学的 Bilal Gökce 教授带领的团队探究了提高纳秒激光烧蚀效率的原理。该研究探讨皮秒至纳秒脉冲持续时间的影响，发现脉冲持续时间在约 1~2 纳秒可以实现最大效率的液相激光烧蚀。

研究发现，不同的实验条件对烧蚀效率影响较大。与几皮秒或高于 5 纳秒的脉冲持续时间相比，在 1 纳秒的脉冲持续时间下运行的激光系统的效率最高。值得注意的是，通过短腔激光谐振腔的调 Q，很容易获得 1 纳秒左右的最佳脉冲持续时间。这样通过使用低成本的调 Q 激光器，可以实现最佳的 LAL 处理，避免了锁模飞秒和皮秒激光器的高投资成本。

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The Flash cannot ablate liquid like these one nanosecond lasers!

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As the key element of photoacoustic imaging system, ultrasound sensors directly decide the imaging performance. To achieve sufficient sensitivity, millimeter scale piezoelectric elements are required, which limits the miniaturization of the device.

A team of scientists, led by Professor Heinz Huber from Munich University of Applied Sciences and Professor Bilal Gökce from the University of Wuppertal, have found the origins of the high efficiency of one nanosecond laser ablation. This study explores pico- to nanosecond pulse duration regimes. They found pulse durations around 1–2 ns enable the most efficient laser ablation in liquid.

Besides scaling up the productivity by increasing the laser power, careful tuning of the laser pulse duration represents another route to optimize the LAL process. It was found that the ablation efficiency varies strongly depending on the experimental conditions. The efficiency is maximal for laser systems operating at a pulse duration of one nanosecond compared to a few ps or >5 ns. Neither a mechanistic explanation has been given, nor single-pulse conditions were applied. It should be emphasized that the optimal pulse duration of ~1 ns is readily available by Q-switching of short-cavity laser resonators. Optimal LAL processing may be possible by utilizing low-cost Q-switched lasers, avoiding the high investment cost of mode-locked femto- and picosecond lasers. Laser ablation synthesis of colloids in liquids is a promising nanomaterial fabrication method.

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