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90 - Atmospheric plume dynamics of a picosecond infrared laser with applications in surgery and biodiagnostics with mass spectrometry

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In principle, lasers allow surgery at the single cell limit. But in practice, shock waves and thermal damage still pose problems. We have employed a picosecond infrared laser lasing at the water absorption peak at $3\mu\text{m}$ to excite water molecules under desorption by impulsive vibrational excitation, leading to ablation processes faster than thermal and acoustic energy transfers. This rapid process greatly reduces the amount of scar tissue when compared to incisions made with scalpels or conventional medical lasers. By selectively exciting the water molecules, intact functional biological entities can be extracted and used for biodiagnostics with mass spectrometry. The combination of rapid ablations and molecule extractions allow for real-time molecular feedback during surgery. The ablation process consists of shock front expansions and material ejections that result in a plume. These nanosecond-long dynamics are captured using bright-field microscopy, allowing us to extract the velocity of the shockwave through images captured at different timings. We observe and characterize plume shapes as a function of laser fluences and material, some of which are liquid water, ice, liquid acetone, and liquid toluene.

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