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Infrared Pulsed Laser Deposition: Applications in Photonics and Biomedical Technologies¹

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Resonant infrared pulsed-laser deposition (RIR-PLD) shows significant promise for synthesizing thin films of small organic molecules, thermoplastic and thermosetting polymers and biopolymers, without compromising structure or functionality. This contrasts with most attempts at UV-PLD of organic materials, which have often been accompanied by severe photochemical or photothermal degradation of the ablated material. Representative recent successes in RIR-PLD include deposition of: polymers for light emission and hole transport; functionalized polymers and nanoparticles for chemical and biological sensing; and biocompatible polymers suitable for coating medical devices or drug-delivery vehicles. Plume imaging and various other optical- and mass-spectroscopy experiments appear to confirm that polymers or organic molecules ablated by resonant infrared laser irradiation experience a high spatial and temporal density of vibrational excitation, but tend to remain in the electronic ground state. The mechanism of RIR-PLD is observed to depend on the anharmonicity of the mid-infrared absorption modes, their finite relaxation time, mode-specific nonlinear absorption, and rapid changes in polymer viscosity as a function of temperature. Many of the RIR-PLD experiments to date were carried out using a tunable, mid-infrared, picosecond free-electron laser. However, if RIR-PLD is to become a practical tool for making organic thin films, it will be necessary to develop more conventional lasers that can achieve a similar combination of high pulse intensity, low pulse energy, high pulse-repetition frequency and moderate average power. In conclusion, the prospects for developing precisely such table-top RIR-PLD systems will be discussed.

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