Pulsed Laser Crushing of Microparticles into Nanoparticles in Liquid Flow– Insights, Upscaling, and Application

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Pulsed laser ablation (LAL) and pulsed laser fragmentation (LFL) in liquids are recognized as the foremost laser-based synthesis and processing methods, facilitating the synthesis of colloidal nanoparticles [1-3]. While LAL has demonstrated productivities approaching 10 g/h, LFL, despite exhibiting throughput one order of magnitude lower, offers access to substantially smaller nanoparticles within the nanocluster size range (<3 nm) [4] through laser-induced phase explosion of nanoparticles [5]. In contrast, microparticle attrition operates via a distinctly different mechanism, reminiscent of particle crushing rather than complete evaporation, yet still affording access to the same nanoclusters. From an application standpoint, pulsed laser attrition of microparticles has the potential to surpass even advanced LAL efficiencies by one order of magnitude [6]. The technical approch is simple: a microparticle dispersion is vertically flowing into the diameter-matched, horizontal laser beam, allowing fully continous and robust operation. By precise alignment of the number of pulses per volume element (PPV), adjustable by matching the laser repetition rate with the particle dispersion's jet flow velocity (residence time), the surface oxidation state of the ultrasmall particles can be adjusted [7], highly relevant for catalysis. This presentation aims to unveil the latest developments in scaling microparticle-LFL (laser crushing), providing application examples of NIR-absorbing materials for additive manufacturing(LaB6-sensitized desktop NIR-Laser Powder Bed Fusion [8]) and heterogeneous catalysis (water splitting by IrOx [6, 7]).

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