LinkedIn White Paper Campaign

CO_2 Powered Sustainability Solutions

CO_2 Composite Spray Technology for Laser Processing
Dual-Mode Contamination Control and Surface Quality Enhancement

Part 1 of 12

SUMMARY

This is Part 1 of a twelve (12) part series regarding CO_2 Composite Spray Technology and how it represents a transformational adjunct for laser-based manufacturing—from post-laser cleanup to integrated contamination control to real-time process optimization.

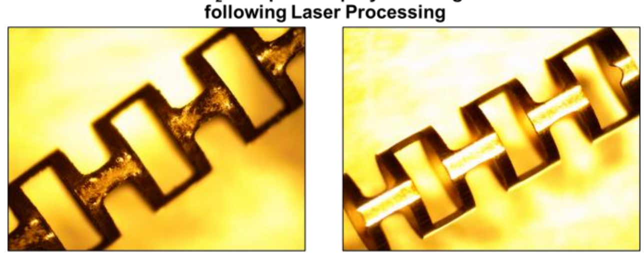
Laser-based welding, cutting, machining, and additive manufacturing enable high-precision production but routinely generate complex surface contamination—including metallic and non-metallic particulates, oxide scales, carbonaceous residues, and entrapped gases—that degrade surface integrity, dimensional control, and downstream joining, coating, sealing, and biocompatibility requirements.[1][2] Traditional post-process cleaning often requires water-based or solvent chemistries that introduce waste streams, drying delays, and environmental compliance burdens.[7]

CO_2 Composite Spray Technology presents a unique bimodal solution that addresses laser-induced contamination and thermal damage through two complementary operational modes:

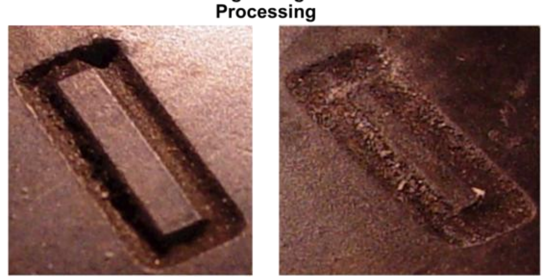
1. **Mode 1: Post-Laser Precision Cleaning** — A high-velocity, micronized CO_2 particles-in-air aerosol jet applied after laser processing as a dry, precision cleaning step that removes particulates, oxides, and films without abrasives or liquids.

2. **Mode 2: In-Process Cleaning and Cooling** — Integrated with the laser head to simultaneously manage the laser plume, suppress contamination

Mode 1
CO_2 Composite Spray Cleaning following Laser Processing



Mode 2
CO_2 Composite Spray Cleaning-Cooling during Laser Processing



formation, clean, and cool adjacent surfaces during active laser operation, improving both surface quality and dimensional control in real time.

Recent polymer machining studies demonstrate the efficacy of this dual-mode approach: CO_2 Composite Spray at ~80 psi applied during 940 nm diode laser machining of fluorosilicone rubber (FSR), butyl rubber (NBR), and polyethylene (PE) yielded superior hole concentricity, kerf definition, and a reported 100–140% reduction in kerf diameter relative to CO_2 gas-assisted baseline conditions.[9] Surfaces showed reduced charring, fewer heat-affected artifacts, and cleaner edges across all polymer types, confirming simultaneous reductions in contamination and improved thermal process control.

When extended to metal welding, cutting, and additive manufacturing, CO_2 Composite Spray reduces rework and scrap, eliminates dependencies on chemical and water-based cleaning, supports real-time quality feedback, and enables manufacturers to align with sustainability and circular-economy commitments through CO_2-powered process integration.

Keywords: laser processing, surface contamination, CO_2 cleaning, composite spray, contamination control, additive manufacturing, polymer machining, sustainable manufacturing.