IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

A MATERIAL PROCESSING SYSTEM AND METHOD THEREOF

IITM Technology Available for Licensing

Problem Statement

- When solid/semi-solid/pulverized materials are processed or analyzed, it often leads to the formation and release of particle clouds that hinder the processing of the materials, resulting in inaccurate data or process, decreased visibility, and equipment damage due to mechanical shockwaves.
- Because of this issue, the existing systems process only solid materials and not semisolid/ pulverized materials. Semisolid/ pulverized materials are made into solids before processing, an additional sample preparation unsuitable for online processing, analysis or characterization.
- There is a need for a reliable, cost-effective system and method for efficient material processing, analysis and characterization that does not suffer from the problems discussed above.

Intellectual Property

- IITM IDF Ref. **2116**
- **IN 531722- Patent Granted**
- **International (PCT) Publication:** WO/2022/195623

TRL (Technology Readiness Level)

TRL 3 Experimental Proof of concept

Technology Category/ Market

Category- Applied Mechanics & Mechanical Engineering
Industry Classification:

- **NIC (2008)- 26511** Manufacture of physical properties testing and inspection equipment; **2592-** Machining; treatment and coating of metals; **26516-** Manufacture of laboratory analytical instruments and miscellaneous
- laboratory apparatus for measuring and testing such as scales, balances, incubators etc
- **NAICS (2022)- 334516** Analytical Laboratory Instrument Manufacturing; **332710-** Machine Shops; **333248-** All Other Industrial Machinery Manufacturing
- **Applications-** Material processing which includes Lasers, optical methods, LIBS analysis, additive manufacturing, welding and cutting

Market drivers: LIBS analysis market is expected to grow with a CAGR of around 6.3% to reach USD 422 Million by 2030; **Additive Manufacturing market** size was valued at USD 20.37 billion in 2023 and is expected to grow a CAGR of 23.3% from 2023 to 2030

Research Lab

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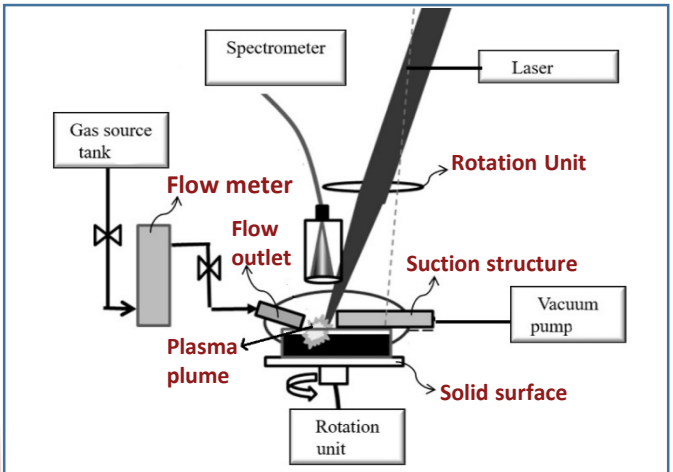

Figure: Illustration of the material processing system comprising a Laser Induced Breakdown Spectroscopy (LIBS) analysis setup

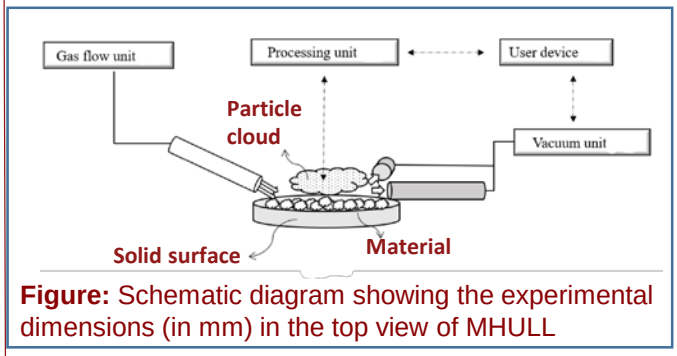

Figure: Schematic diagram showing the experimental dimensions (in mm) in the top view of MHULL

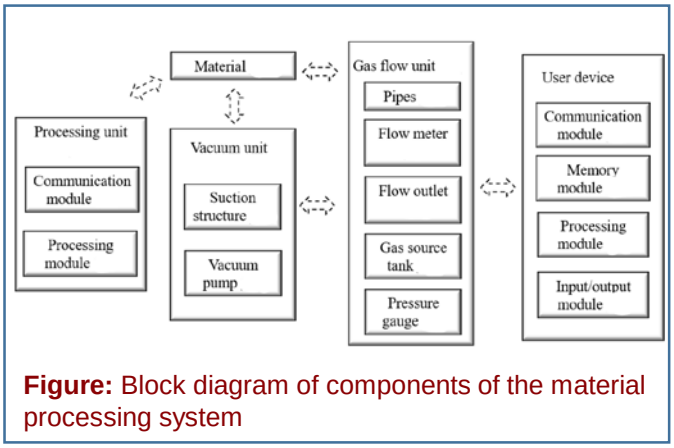

Figure: Block diagram of components of the material processing system

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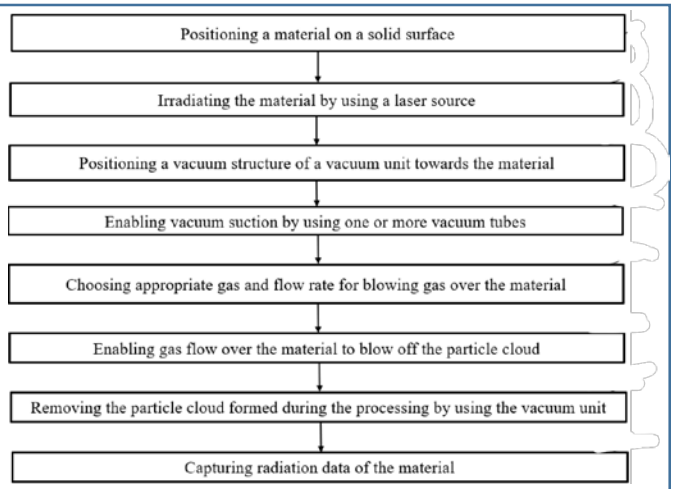

Figure: Method for the LIBS material processing system

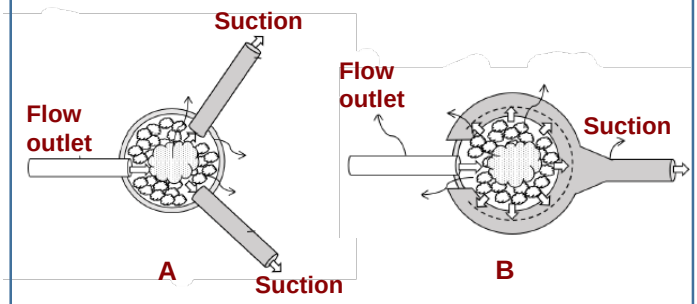

Figure: Top view of suction structures in the material processing system with Straight **(A)** and Curved Vacuum tubes **(B)**

Technology

The material processing system configured to remove particles cloud formed during processing comprises- a solid surface for positioning the material, a processing unit for processing the material, and a vacuum unit operatively connected to the processing unit.

The vacuum unit comprises a suction structure positioned towards the material such that vacuum suction is created around the material to minimize or eliminate the particle cloud. The vacuum tubes may comprise one or more shapes, such as a straight tube, a curved tube or a combination of both.

the material processing system can be configured to remove a particle cloud formed during one or more processes such as LIBS analysis. In this case, the material processing system comprises a laser source for irradiating the material and a spectrometer for capturing radiation data of the material.

The laser pulse creates a plasma plume, and the resulting thermal waves and mechanical shock waves lift all smaller particles in the material and produce a particle cloud.

A spectrometer is used to capture the characteristic spectra of the material, using which an elemental analysis can be conducted on the material.

Key Features / Value Proposition

- When an inert or near-inert gas is used, the gas flow also helps create an inert micro-atmosphere, which hinders atmospheric interference and contamination of the process and prevents any chemical reactions that may occur otherwise.
- The vacuum tubes may comprise all-around suction around the plasma plume along with gas flow from one direction to avoid the shielding effect of the particle cloud over the plasma plume.
- The setup enhances the emission intensity by reducing the scattering of the optical emission and the incident laser beam, thus making the Laser-Induced Breakdown Spectroscopy (LIBS) process more efficient and accurate compared to conventional LIBS setups with no-flow conditions.

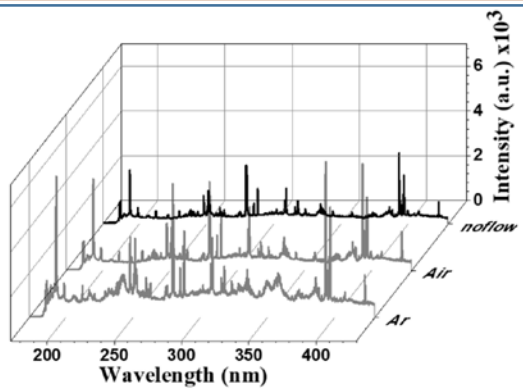

Figure: A comparison of the three LIBS emission spectra reveals that Air flows to remove the particle cloud from the ablation region improved the LIBS emission signal intensity, and the Ar flow increases the signal strength by the combined effect of inert gas and particle cloud removal, compared to the no-flow condition.

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