Data Evaluation in Laser Crater Experiment

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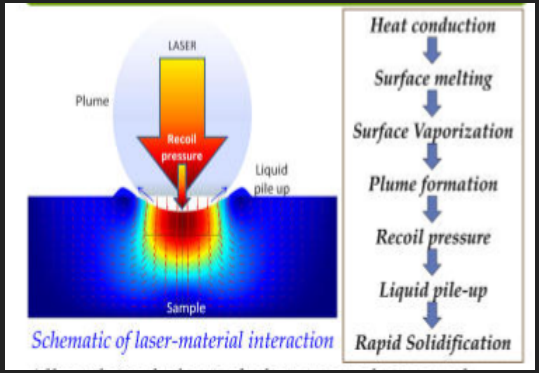
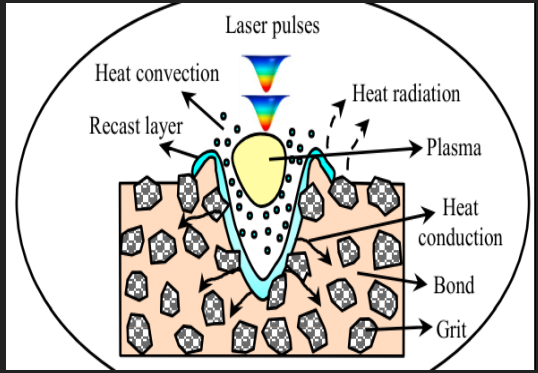
Outline

- Introduction
- Methodology
- Data Analysis for Crater Study
- Conclusion

Fundamental concepts

1 Introduction

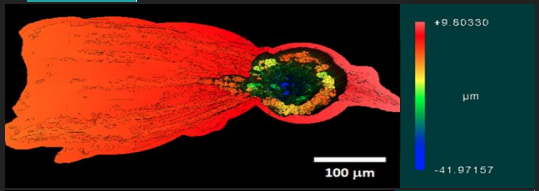


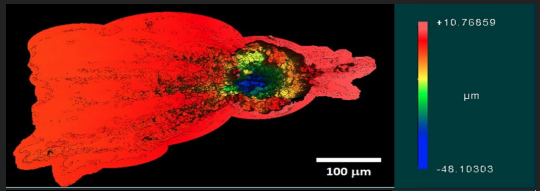


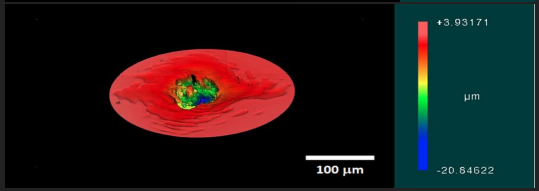
- A high-intensity laser beam is focused onto a material's surface.
- The laser energy rapidly heats and vaporizes the material, creating a localized explosion.
- This explosion ejects material, forming a crater at the impact site.

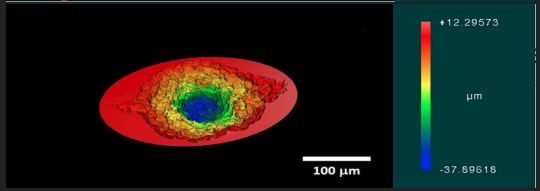
Motivation

1 Introduction







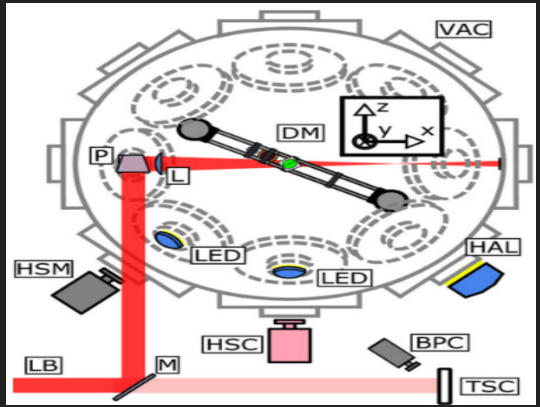


Polymerized UDMA-TEGDMA(Au0 (Without Gold) & Au2 (With Gold)):
Au0_045 (upper left panel), Au2_068 (upper right panel),
L03_Au0 (lower left panel), L03_Au2 (lower right panel).
We must determine the volume for each of these multiple types.

Experimental Setup

2 Methodology

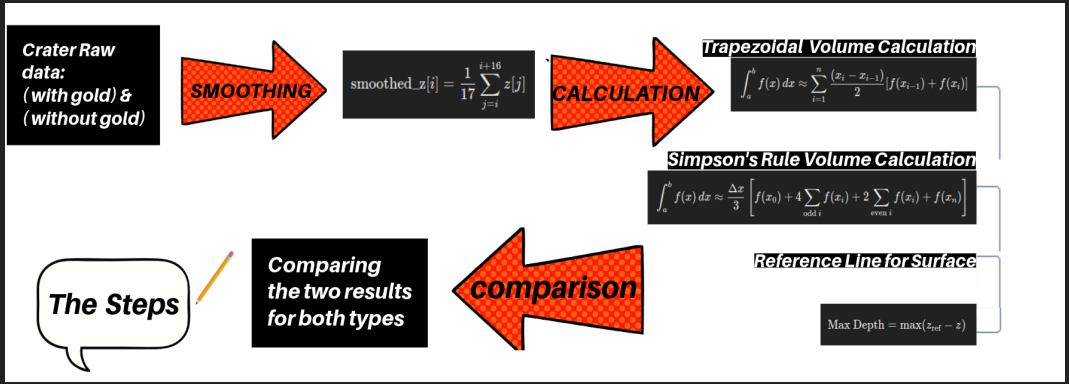
VAC: vacuum chamber, DM: dropping mechanism, P: periscope, L: Lens, LED: LED-lamp, HAL: halogen lamp, HSM: high-speed camera monochrome, HSC: high-speed camera color, BPC: beam profiling camera, LB: Laser beam, M: mirror, TSC: PTFE screen, HM: holding magnet, T: target, BP: burn pattern foil, PS: pressure spring, DA: dropping arm, HS: holding springs.



Setup & Parameters: Laser Source: Ti:Sa , wavelength: 795 nm, pulse Length: 42 fs , intensity: $10^{16} - 10^{17}$ W/cm^2, pulse Energy :(1, 5, 10, 15, 20, 25) mJ, laser Intensity :(10 , 25-27.7)mJ, VCP: $\sim 10^{-6}$ Pa, illumination Direction: 45°

Data Collection

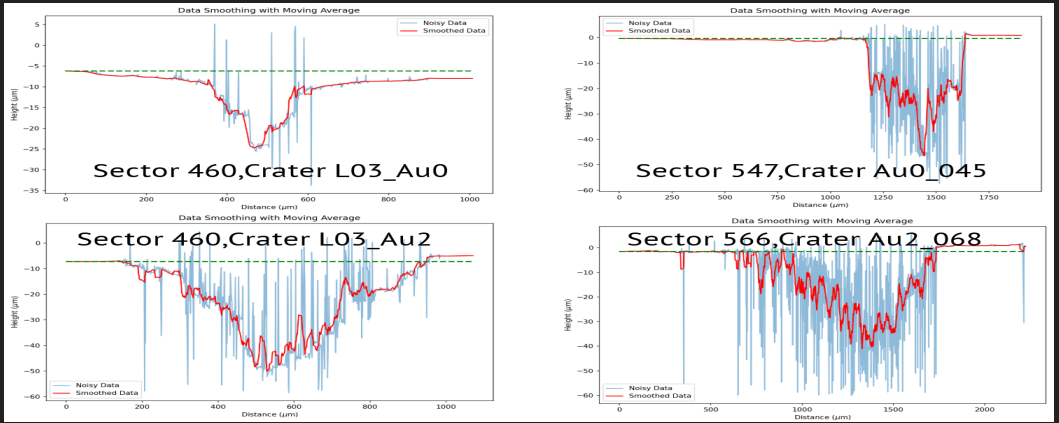
2 Methodology



Each of all, these procedures guaranteed precise surface profile measurement and analysis, allowing a thorough understanding of it's properties.

Data Smoothing

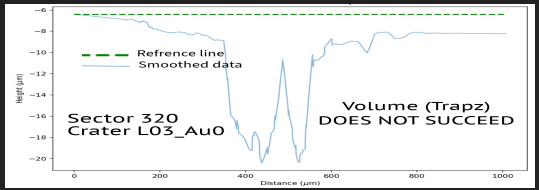
3 Data Analysis for Crater Study

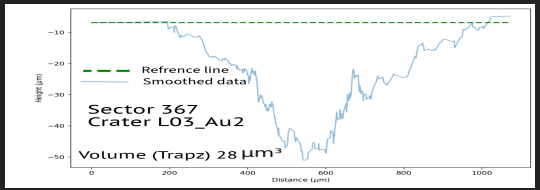


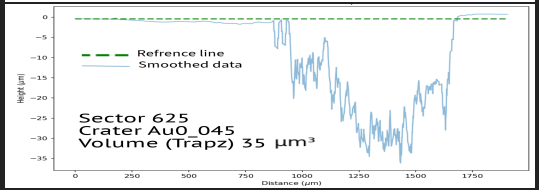
Apply Moving Average Smoothing: Smooth data with a specified window size(17 in my case) to reduce the noise in the crater measurements.

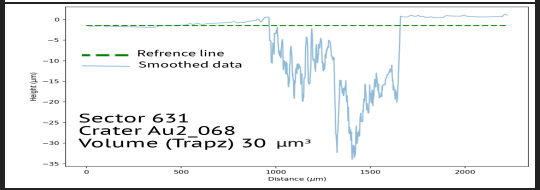
Volume Calculation - Trapezoidal Rule

3 Data Analysis for Crater Study





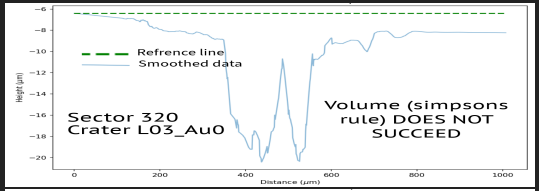


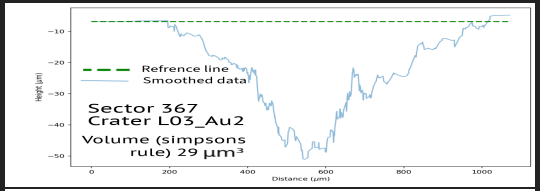


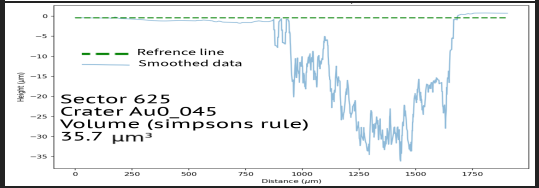
The volume calculation using methods like the trapezoidal rule helps (as initial stage) quantify material removal and assess the effectiveness of plasma treatments on different surfaces.

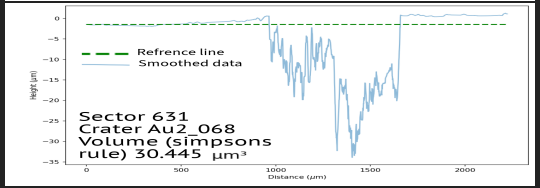
Volume Calculation - Simpson's Rule

3 Data Analysis for Crater Study





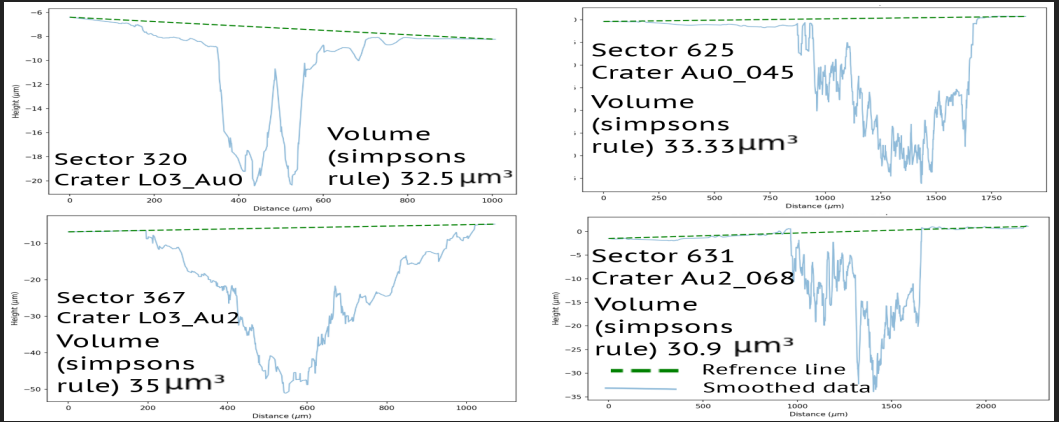




Simpson's rule provides a more accurate estimate of the volume under the curve compared to simpler methods like the trapezoidal rule. This is especially beneficial when dealing with irregularly shaped curves or highly variable data

Reference Line for the volume

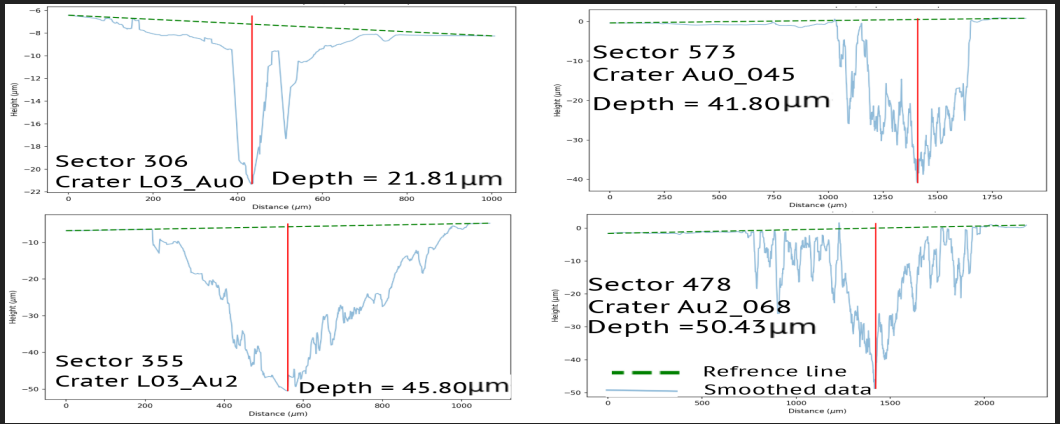
3 Data Analysis for Crater Study



We construct a continuous reference line that roughly corresponds to the crater's surface in order to define the crater's boundary.The area between the smoothed curve and the reference line is used to estimate the crater's volume.

Depth Calculation

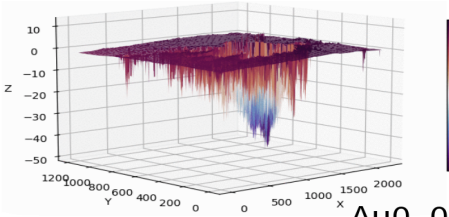
3 Data Analysis for Crater Study



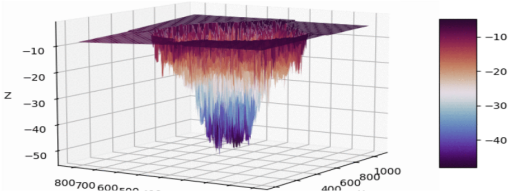
Depth: Measuring from the surface to the deepest point of the crater. To understand the total impact on the surface (with gold) and to focus on the damage to the underlying material (without gold).

3D Plotting

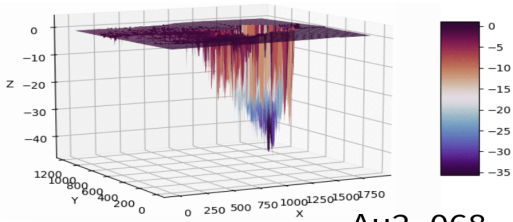
3 Data Analysis for Crater Study



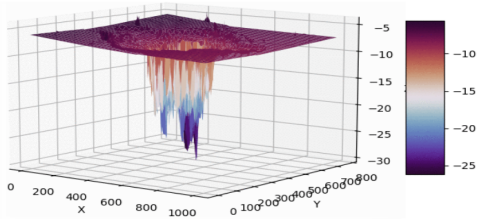
Au0_045



L03_Au2



Au2_068



L03_Au0

Comparison with and without gold

Parameter	Au0_045	Au2_068	Lo3_Au0	Lo3_Au2
Trapz Volume (μm³)	239,298.4	-140,376.8	4,967.3	-51,727.1
Simpson Volume (μm³)	239,939.3	-140,390.1	4,969.8	-51,729.8
Reference Line (μm³)	-399,798.2	-204,668.1	-7,747.3	-66,692.3
Average Depth (μm)	19.8	35.0	14.4	40.2

Table 1: The values for each parameter are provided for different samples (Au0_045, Au2_068, Lo3_Au0, Lo3_Au2). The comparison of volume calculations using different methods (Trapz and Simpson), along with additional data for the reference line and average depth.

Summary of key results

5

Outcomes show how we initially used these methods to obtain a more accurate crater calculation. To check if it still functions, we intend to give it another go.

- we analyze the volume calculations for different samples (UDMA-TEGDMA(Au0 (Without Gold) & Au2 (With Gold)) in different experimental conditions.

- crater volumes and depths increase rapidly at higher intensities or the energy of the laser pulse in samples embedded with gold nanorods.

- The values for the reference line provide information about the baseline or background volume level.

- The average depth of the craters provides insights into the depth of material removal during the crater formation process.

Data Evaluation in Laser Crater Experiment

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Thank You For Your Attention!

Questions...