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Evaluation Quality of 3D Printed Clay Objects Using a 3D Structured Light Scanning System

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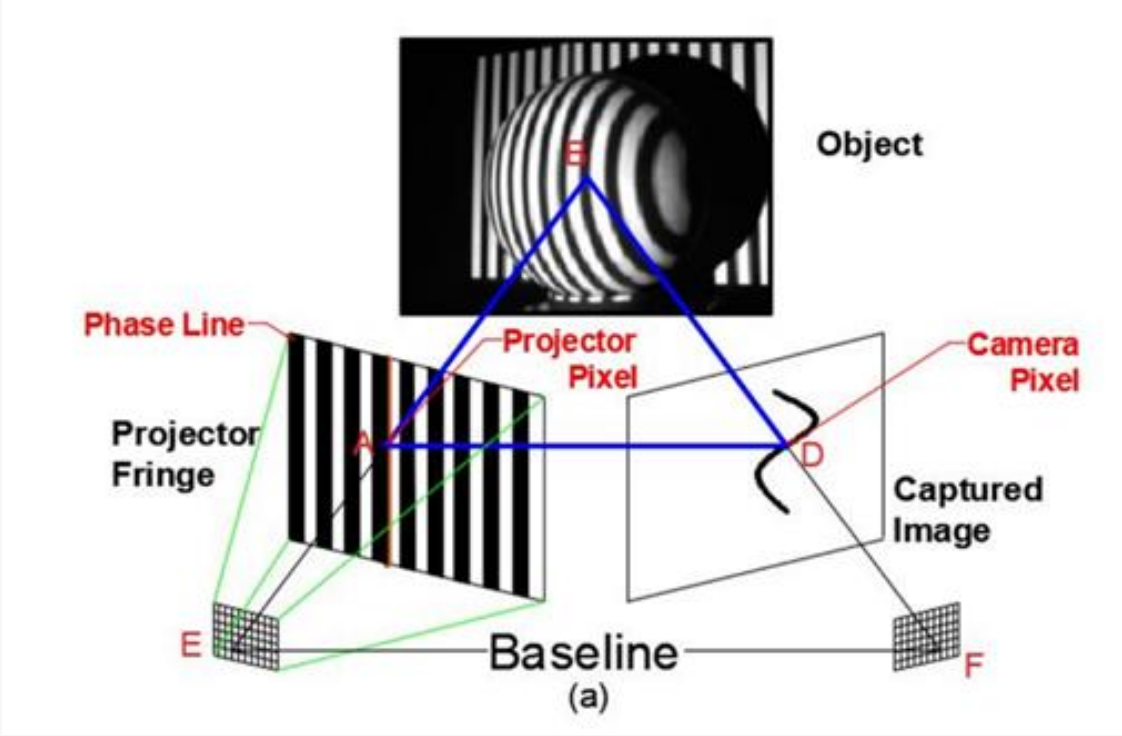
Research background

3D printed clay with complicated shapes

3D printed concrete with different mix proportions

3D-SLSS

3D-SLSS: 3D-Structured Light Scanning System



Schematic diagram of operating concept of 3D-SLSS

Objective

(1) To explore the potential of 3D-SLSS's application in 3D printing quality evaluation

(2) To develop a test protocol for 3D scan and image analysis

(3) To identify parameters that govern 3D printing quality

(4) To quantify the printing quality of the samples studied

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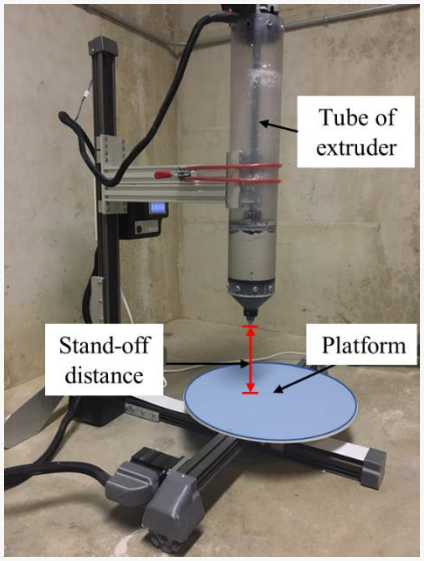
Materials & Printing process

Physical and chemical properties of clay

	Water content (%)	Plasticity (IP Atterberg)	Carbonate content (%)	Drying shrinkage (%)	Porosity at Cone 10
Clay	25.42	16	0	8.5	0



3D printer

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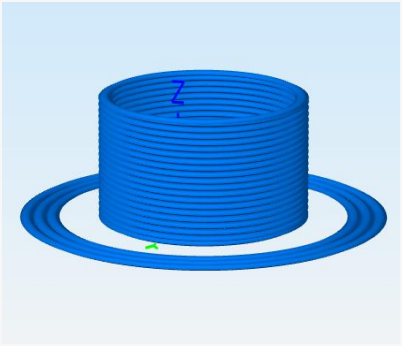
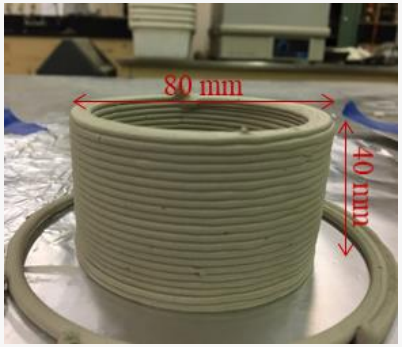
Materials & Printing process

Printing parameters

	Printing speed (mm/s)	Extrusion flow rate (mL/s)	Stand-off distance (mm)	Layer width (mm)	Layer thickness (mm)
Sample 1	30	0.38			
Sample 2	105	0.38	2	5	2
Sample 3	60	0.30			



3D modeling



3D printed sample

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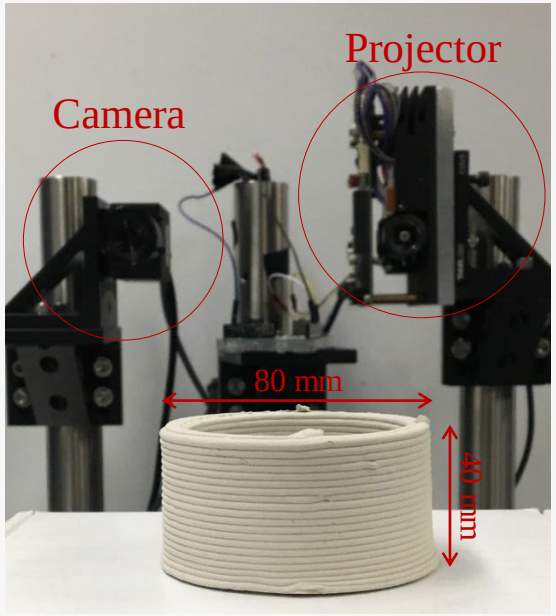
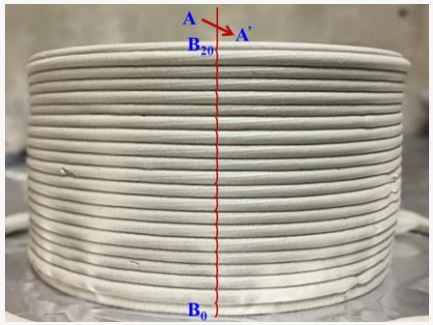
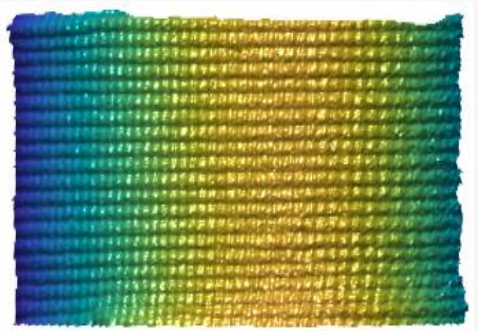
Image analysis



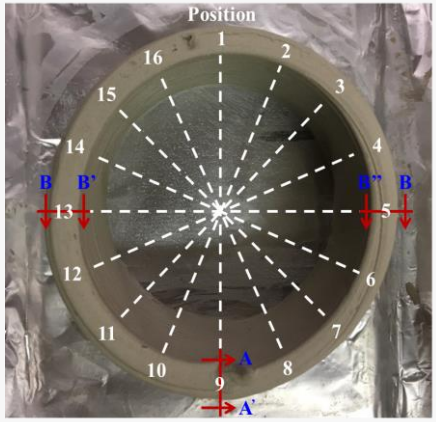
3D-SLSS set up



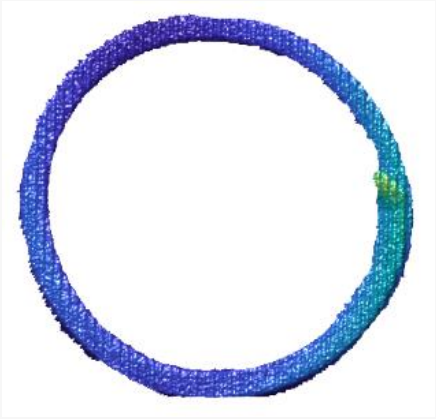
Side view



Example 3D image from side view



Top view



Example 3D image from top view

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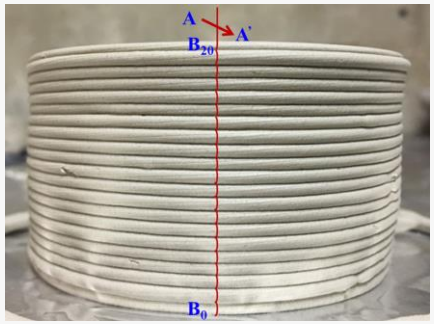
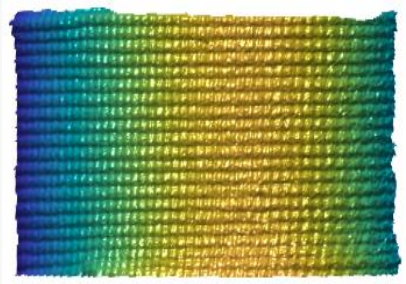
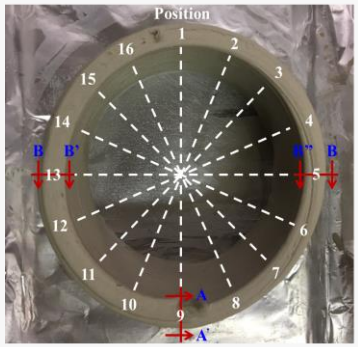
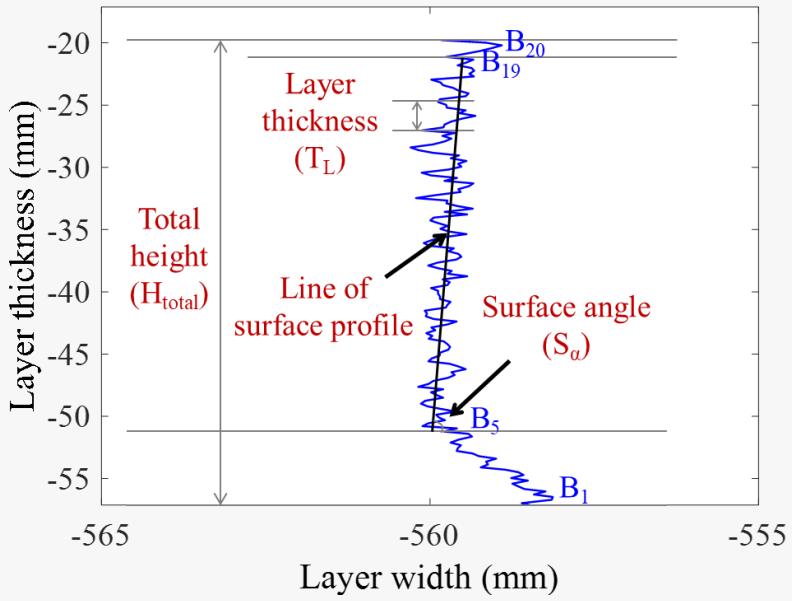
Image analysis

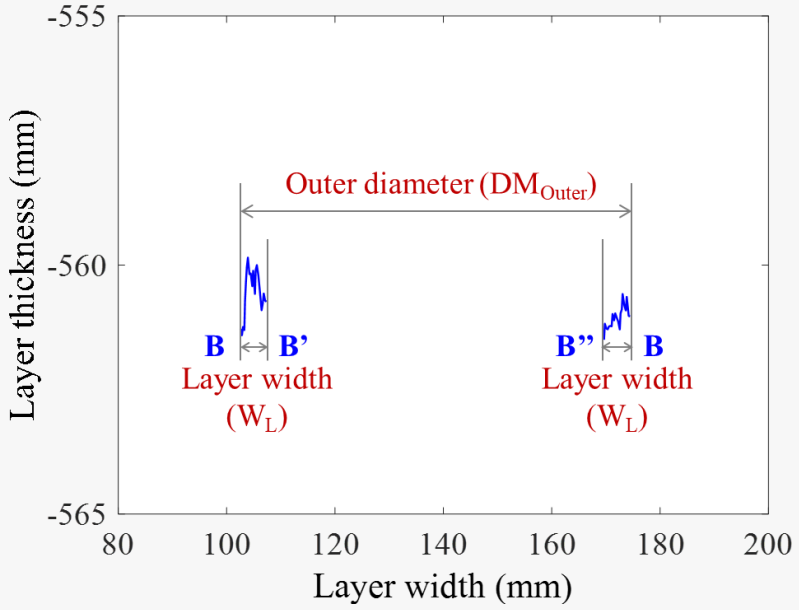








2D plot from side view



2D plot from top view

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Image analysis

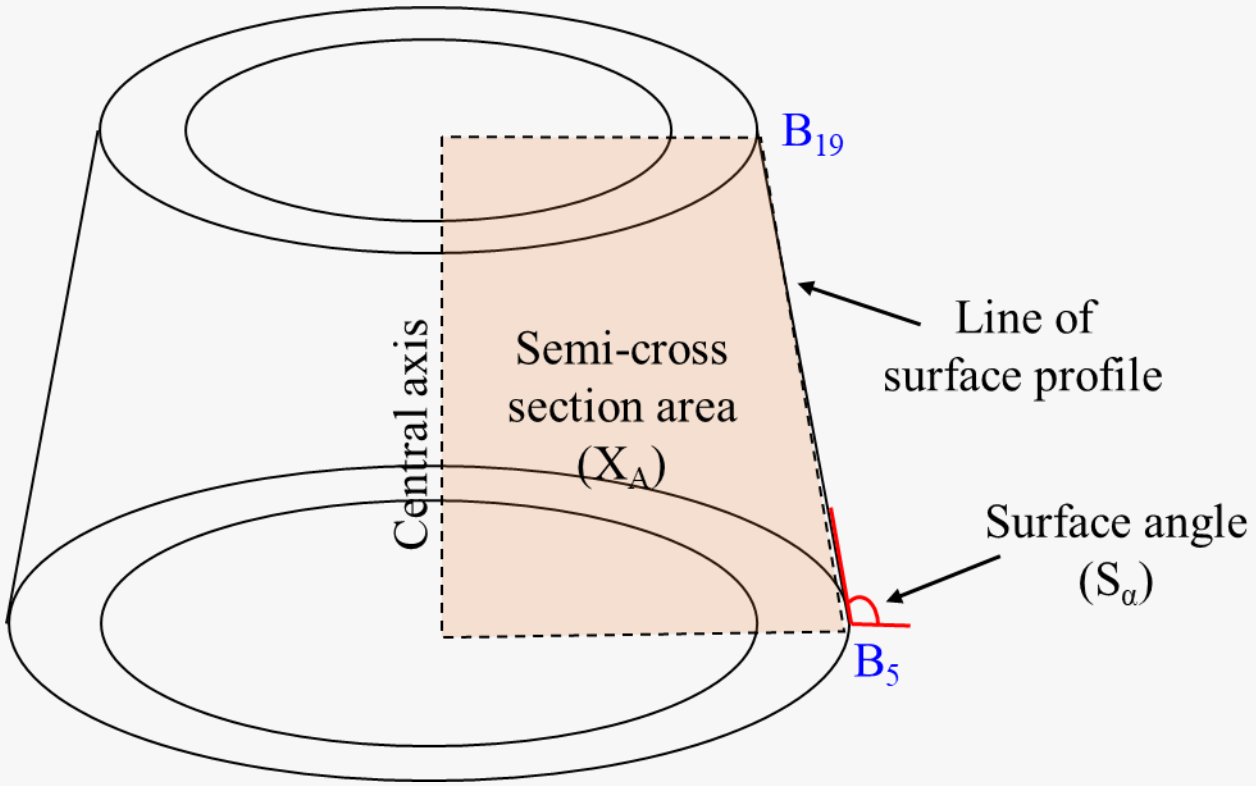

Illustration of surface angle and semi-cross-section area

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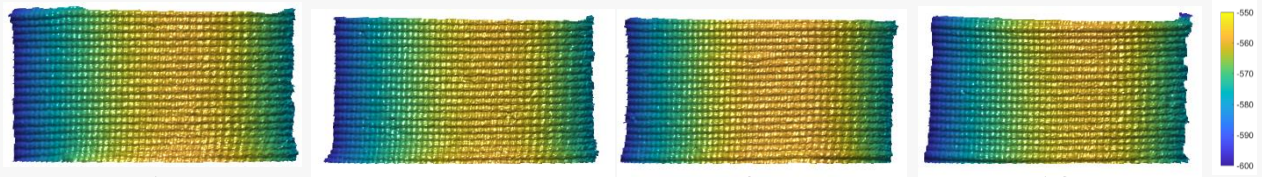
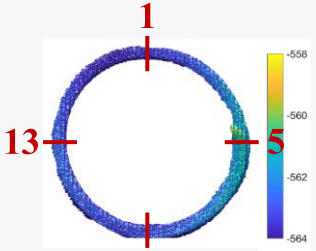
3D Images

Sample 1 (PS: 30 mm/s, ER: 0.38 mL/s)

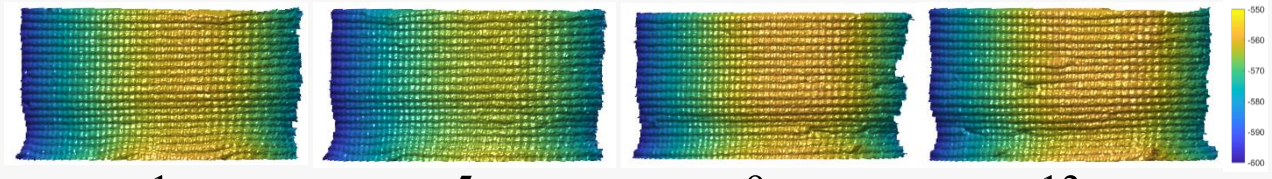


Side view

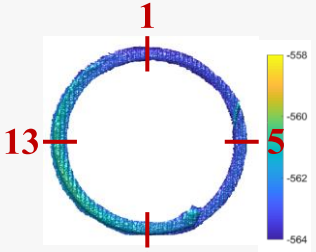


Top view

Sample 2 (PS: 105 mm/s, ER: 0.38 mL/s)

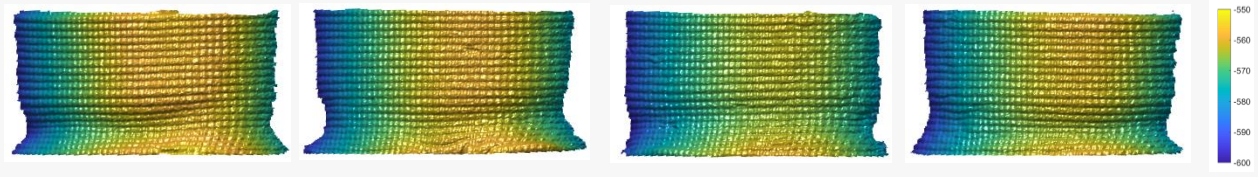


Side view

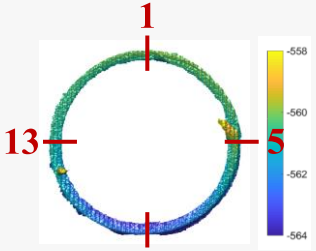


Top view

Sample 3 (PS: 60 mm/s, ER: 0.30 mL/s)



Side view



Top view

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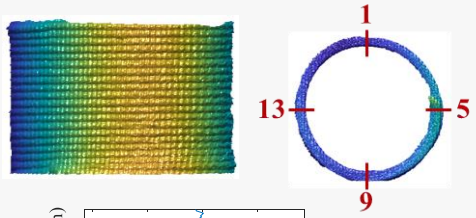
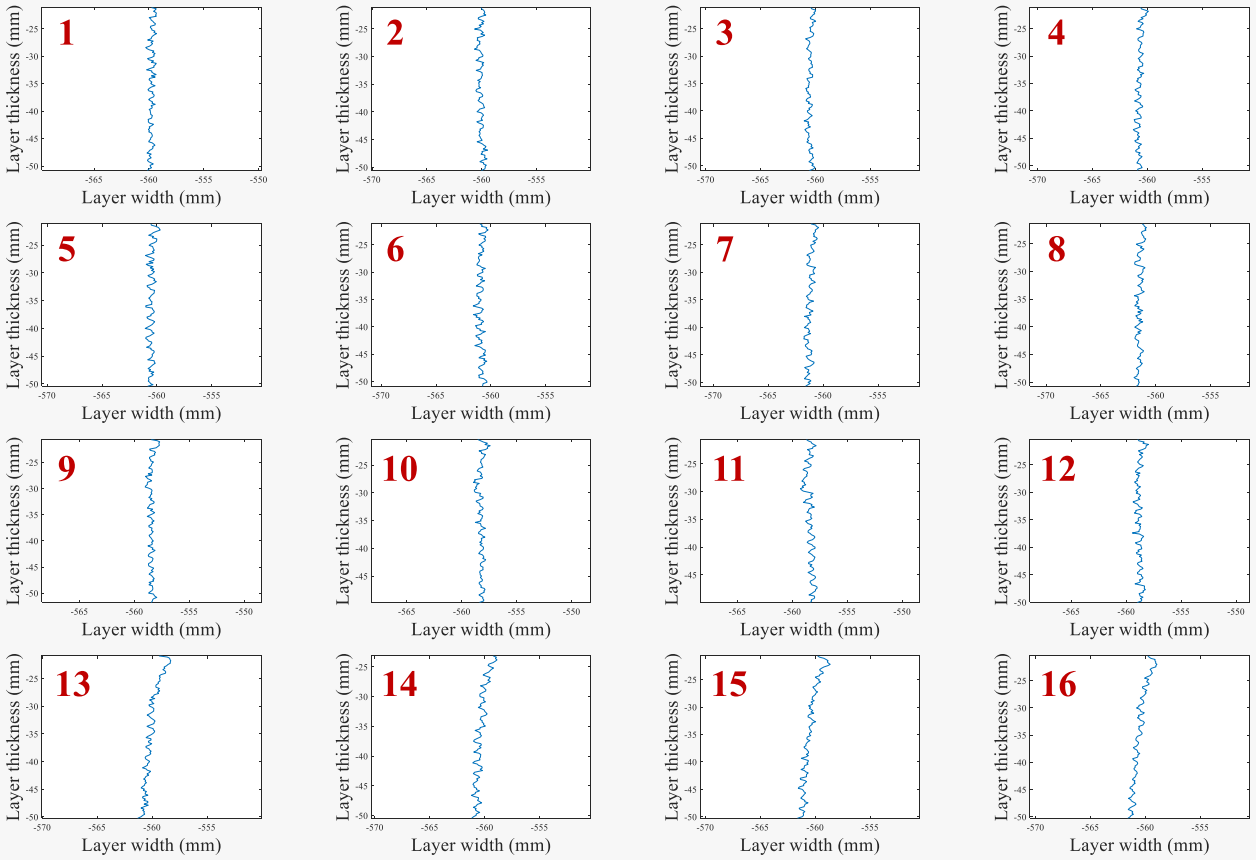
Surface Profiles





Surface profiles of sample 1

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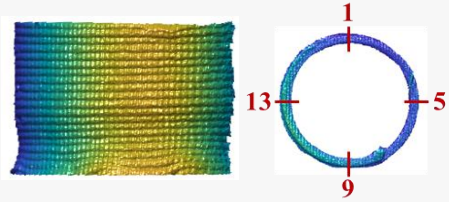
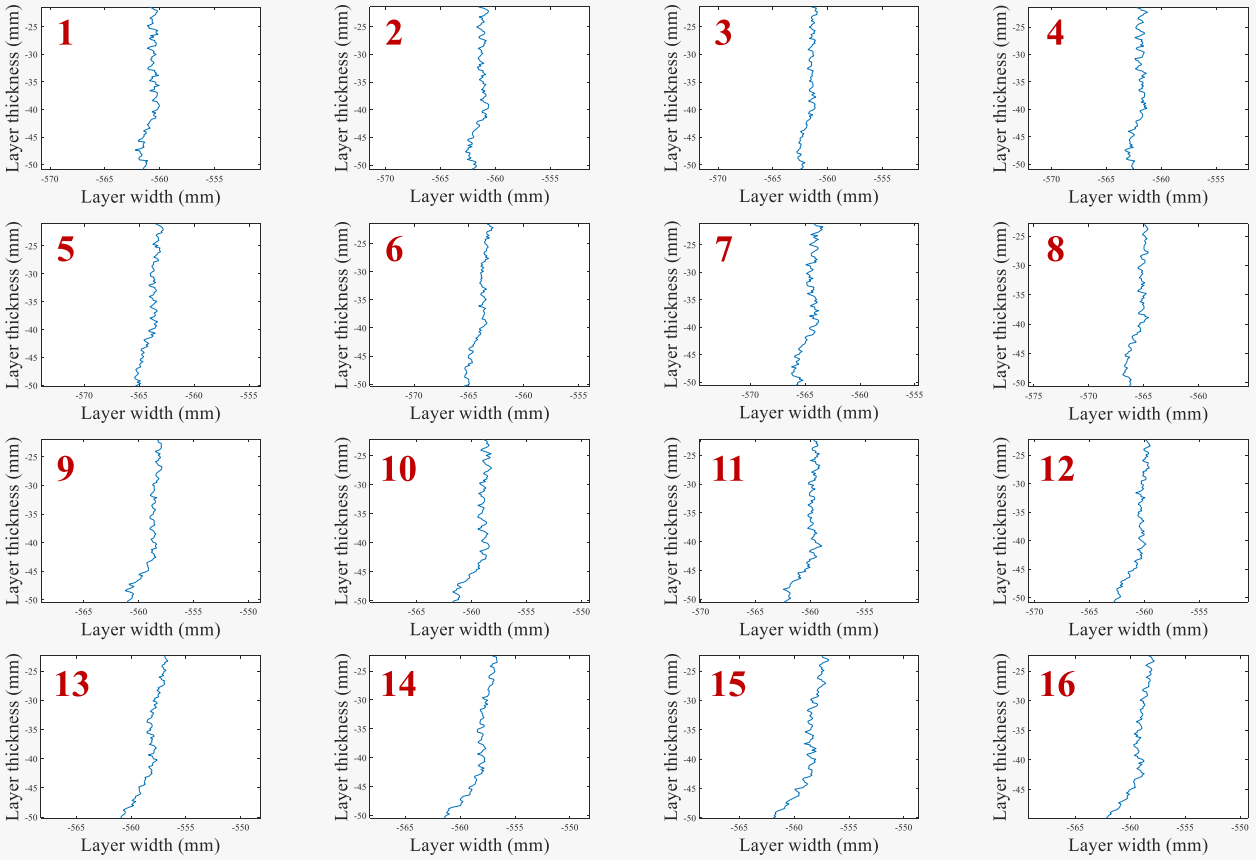
Surface Profiles





Surface profiles of sample 2

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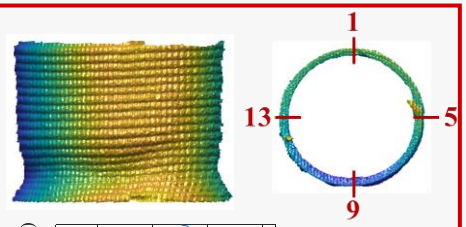
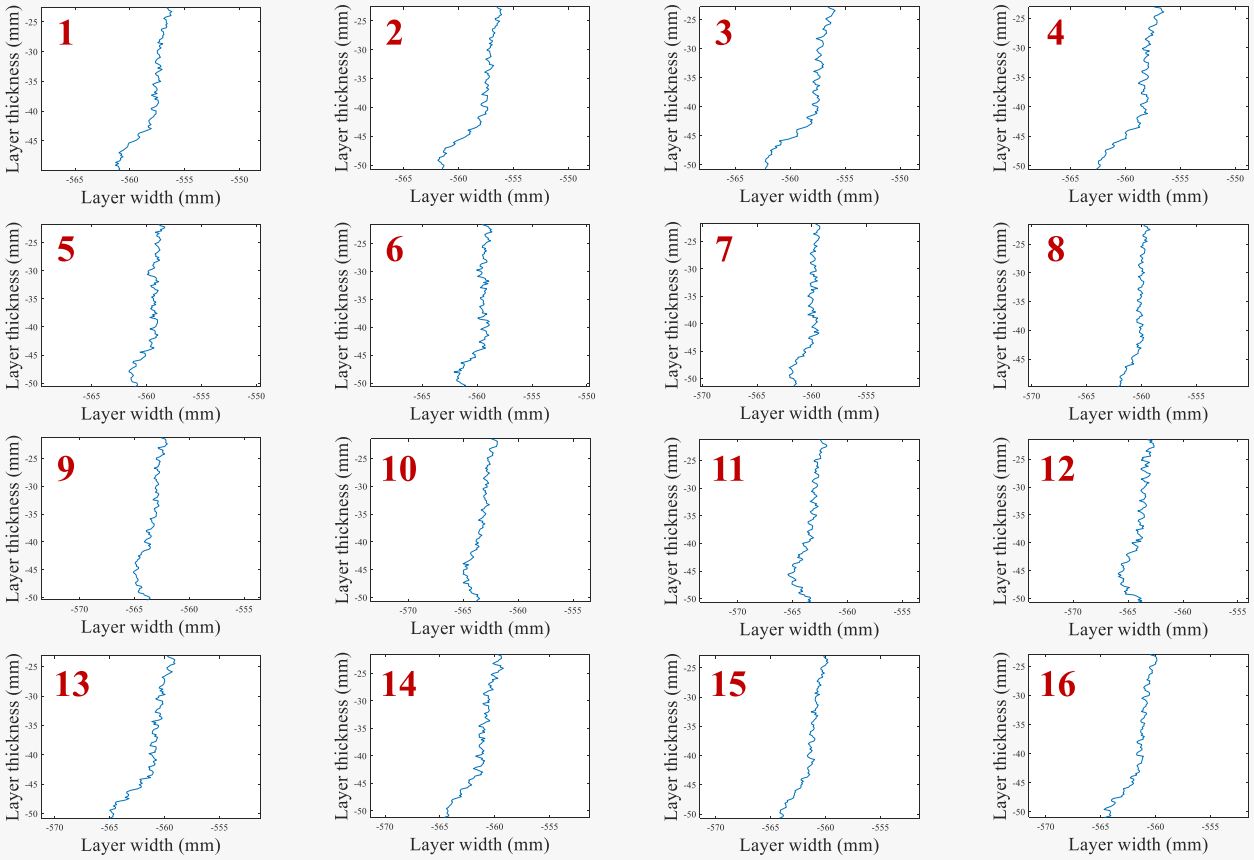
Surface Profiles





Surface profiles of sample 3

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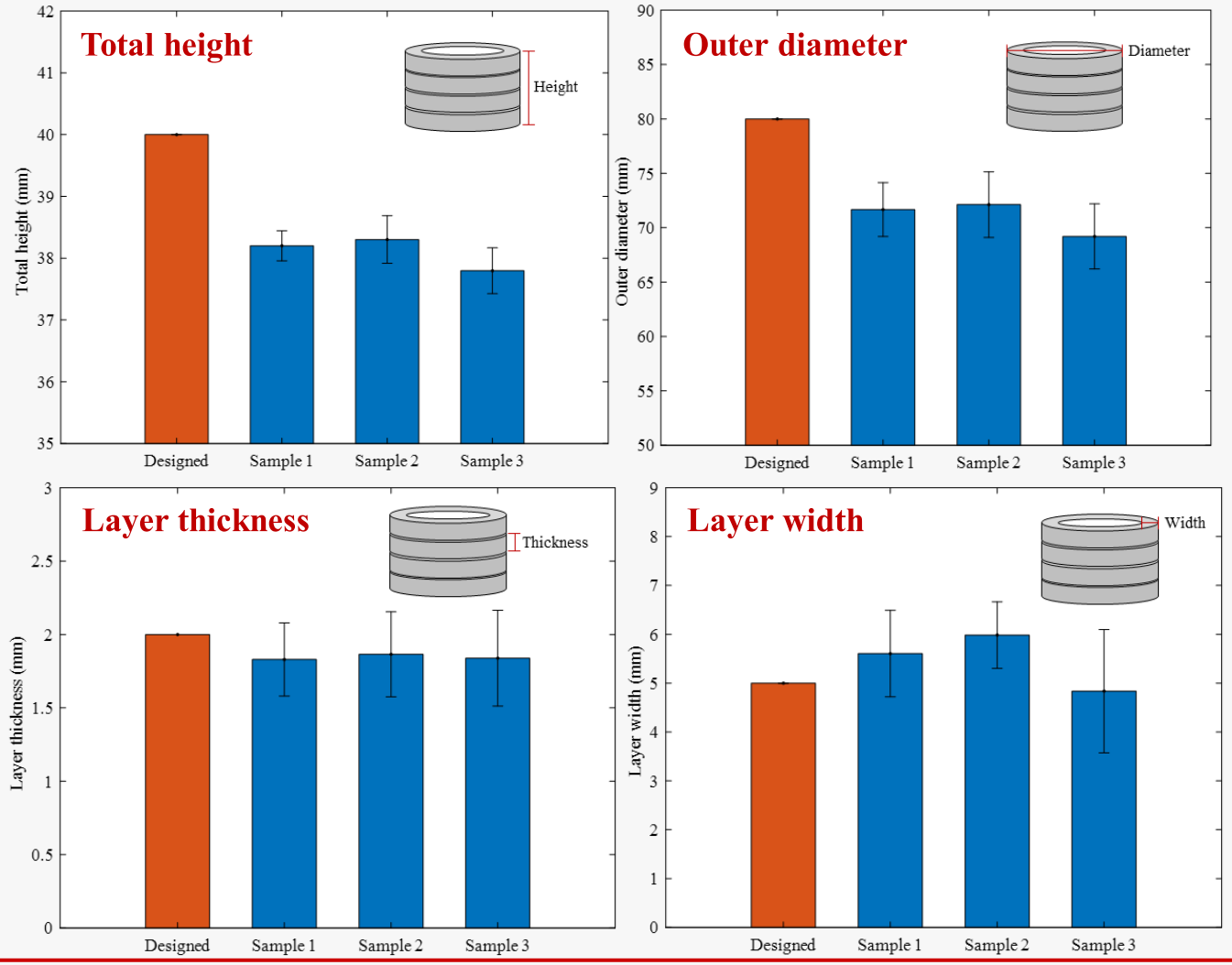
Geometry characterization



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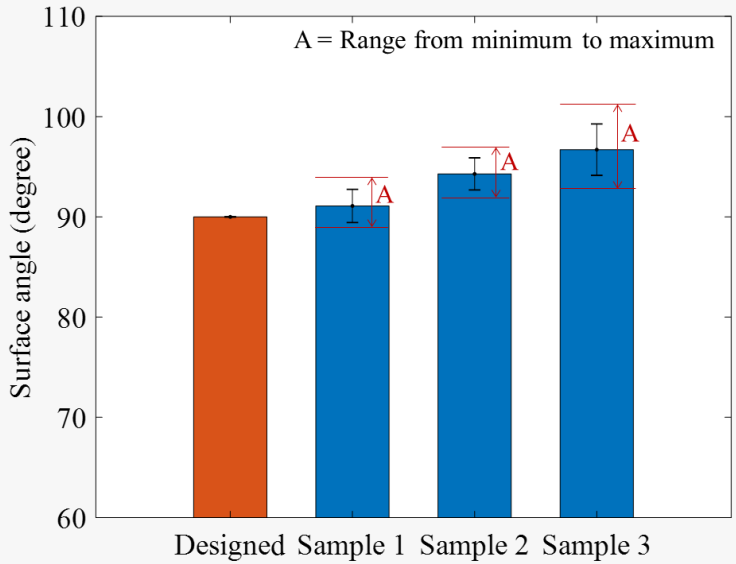
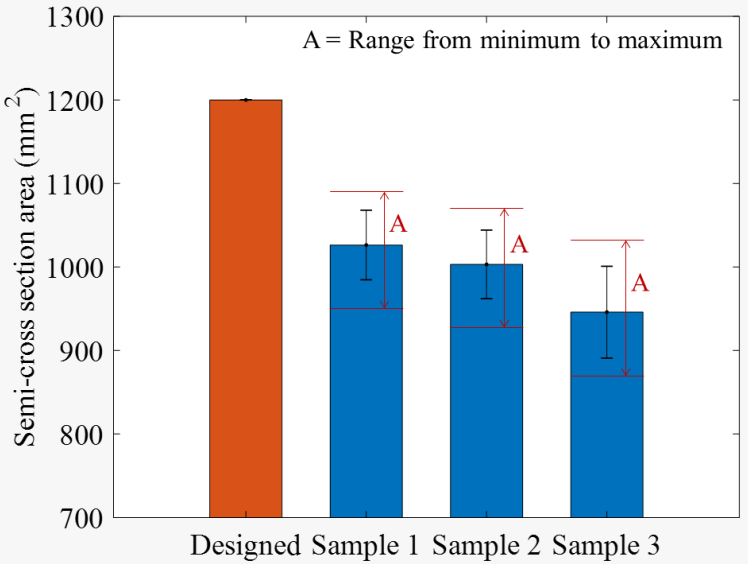
Distortion



Surface angle



Semi-cross-section area

Distortion angle and area of printed samples

	Surface angle (degree)	Semi-cross-section area (mm^2)	Distortion angle (degree)	Distortion area (mm^2)
Designed	90	1200	0	0
Sample 1	91.08	862.7	1.089	337.2
Sample 2	94.28	868.6	4.286	331.3
Sample 3	96.70	805.6	6.706	394.3

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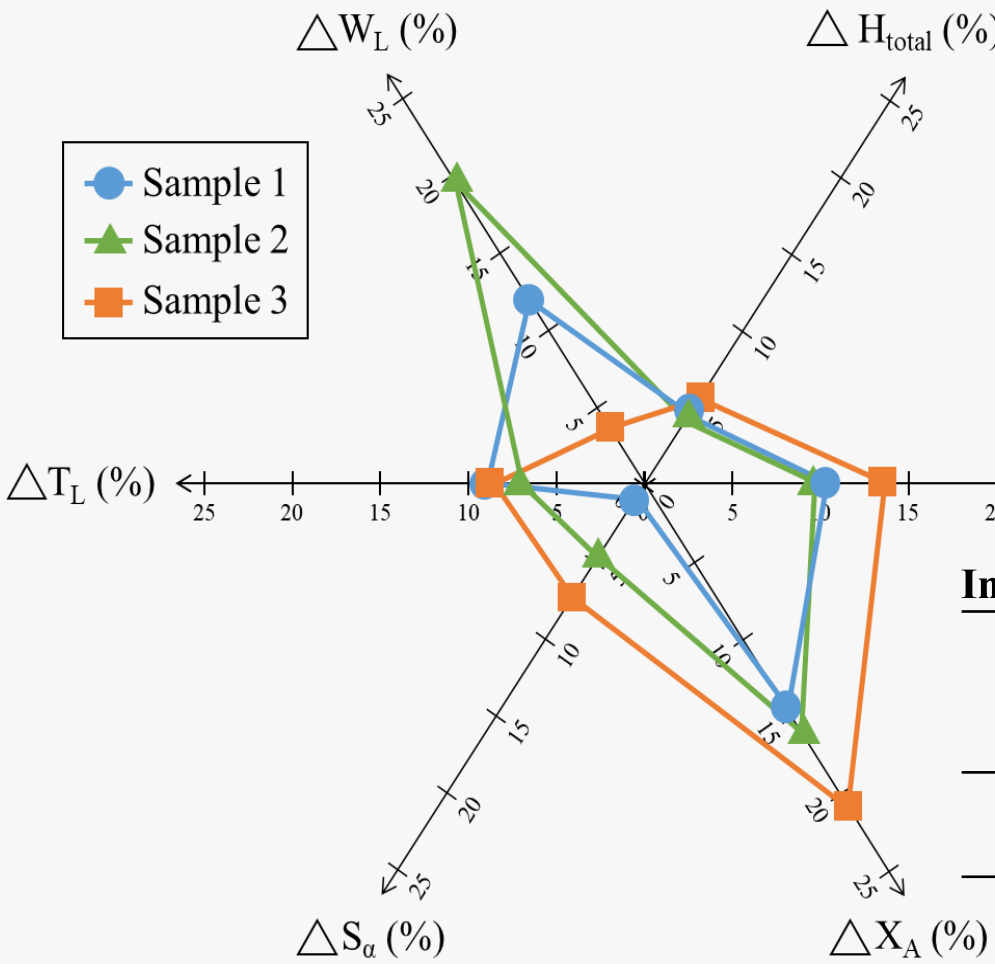
Integrated evaluation



Integrated evaluation

	Sample 1	Sample 2	Sample 3
Area	238.531	286.784	**378.467**

Conclusions

1) No samples studied had measured values equal to the designed values, although those appeared well-printed. Therefore, **it is important to identify key parameters and quantify printing quality**.

2) Printed clay samples generally exhibited reduced total height, diameter, and layer thickness (corresponding to the increased layer width), and measurable distortion. This is mainly because the **freshly printed clay material deformed under the weight of the layers above**.

3) 3D-SLSS provided accurate measurements for geometric parameters and well quantified the degree of distortion of 3D printed products. This method can be extended to quantify the 3D printing quality of cement-based materials.