Controlling the Wettability of Materials by Adjusting Surface Plastic Deformation Through Post-Processing Methods Involving Friction Modification

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Purpose

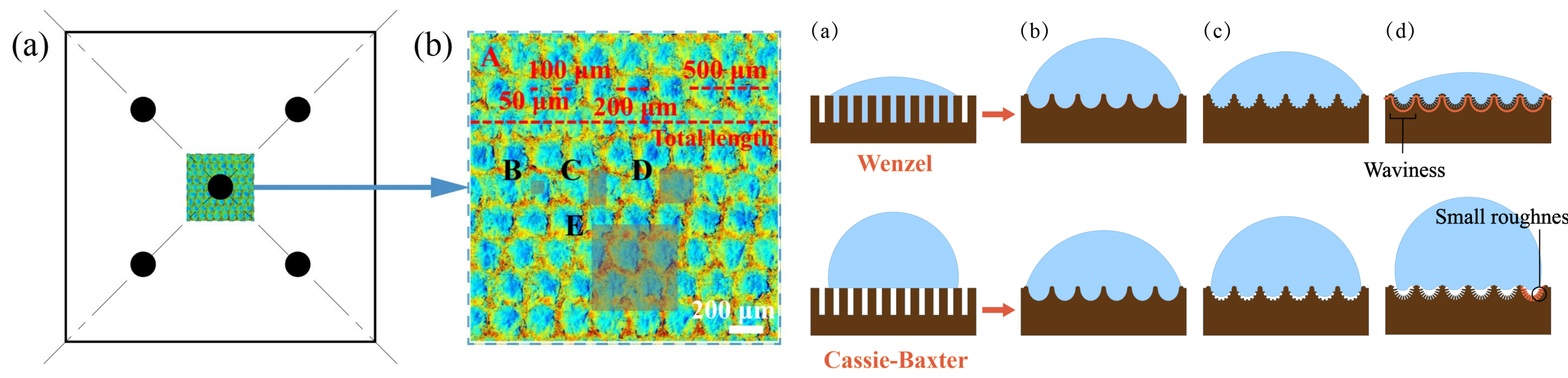
Methods for controlling surface plastic deformation can alter the wettability of materials and contribute to a certain level of strengthening effect, thereby presenting significant application potential. This study aimed to modify the wetting characteristics of aviation titanium alloys in harsh environments through adjustments in surface roughness via peening treatments, such as laser shock peening without coating (LSPwC) and mechanical shot peening (MSP).

Methods

Table 1. Sample materials and surface treatment processes

	1	2	3	4	5	6
Materials	Ti60	Ti60	Ti60	TC11	TC11	TC11
Methods	MSP	LSPwC	LSPwC	MSP	LSPwC	LSPwC
Parameters	0.3 mmA	50 mJ	80 mJ	0.3 mmA	50 mJ	80 mJ

Figure 1. Schematic diagram of sampling and wettability model



Results

Figure 2. Surface topography and roughness results

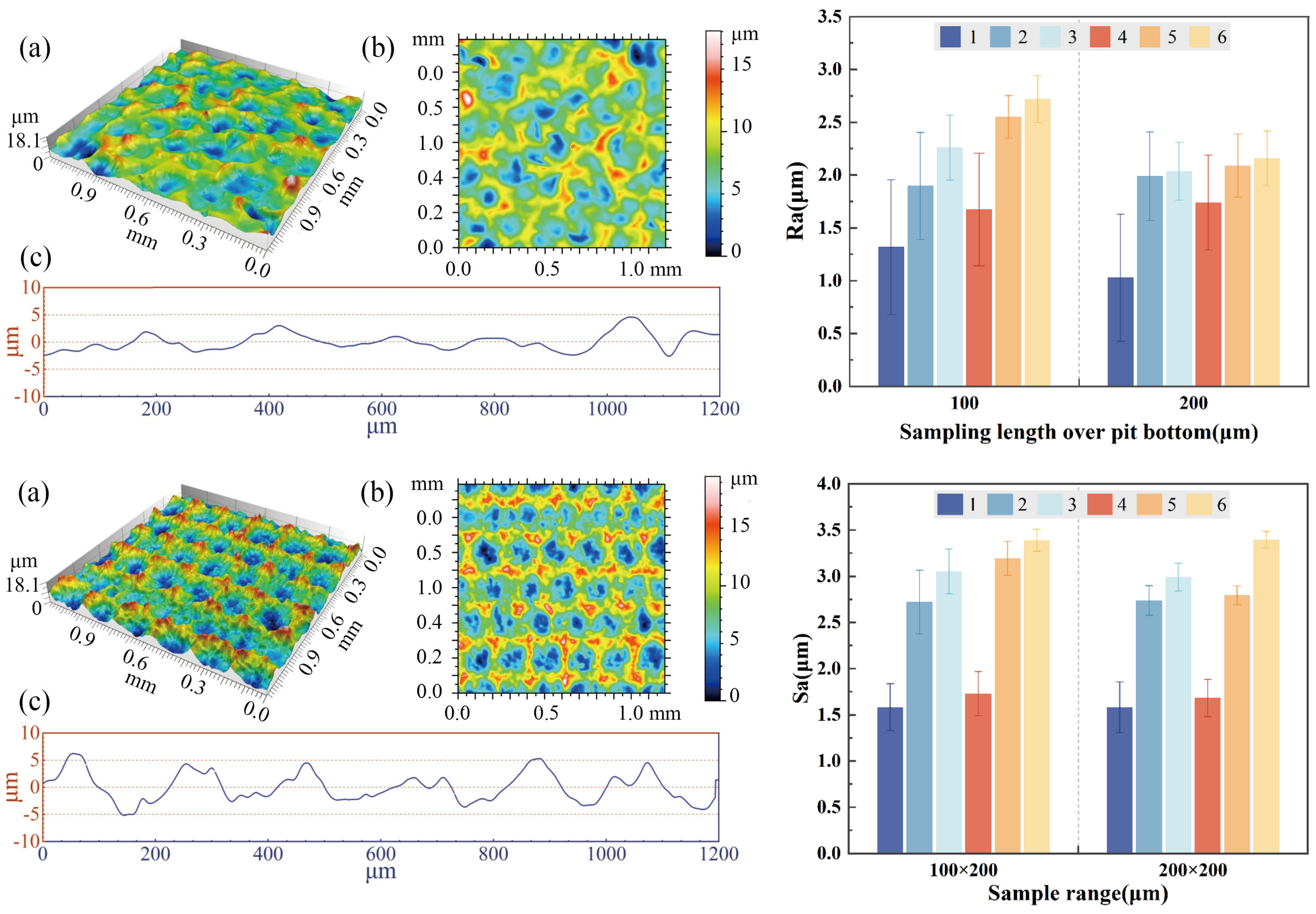


Table 2 and Figure 3. Residual stress and FWHM results

	Residual Stress(MPa)	Average Peak FWHM(°)
1	-576.96±39.07	4.32±0.70
2	-153.64±22.94	2.95±0.04
3	-330.62±36.82	3.13±0.16
Ti60	**-133.10±9.20**	**2.62±0.07**
4	-602.31±34.53	4.25±0.07
5	-245.11±14.99	2.49±0.03
6	-344.04±10.31	3.02±0.13
TC11	**-133.65±12.06**	**2.60±0.01**

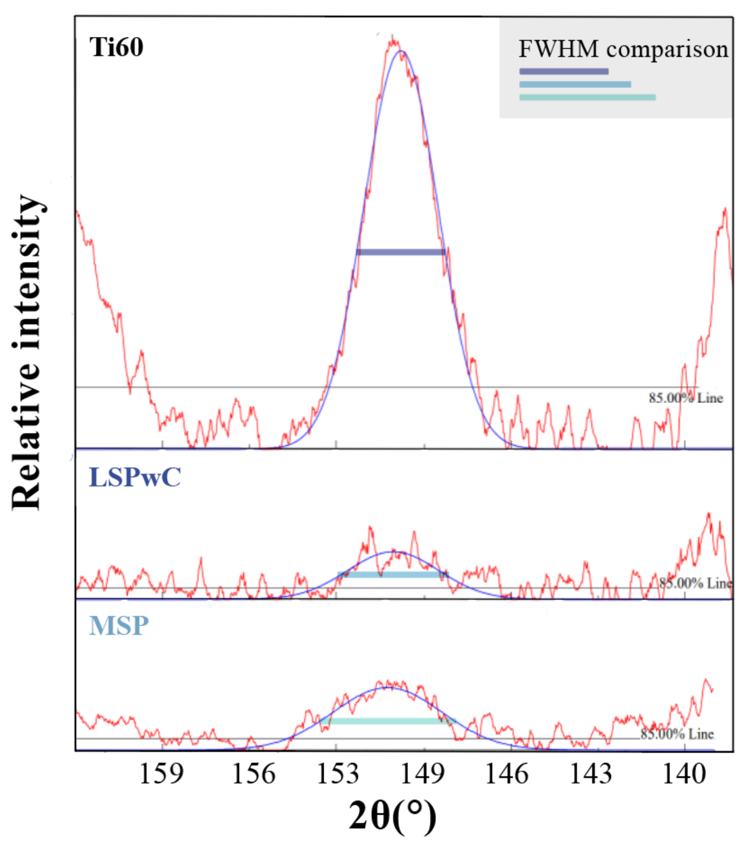


Figure 4. Contact angle and surface energy test results

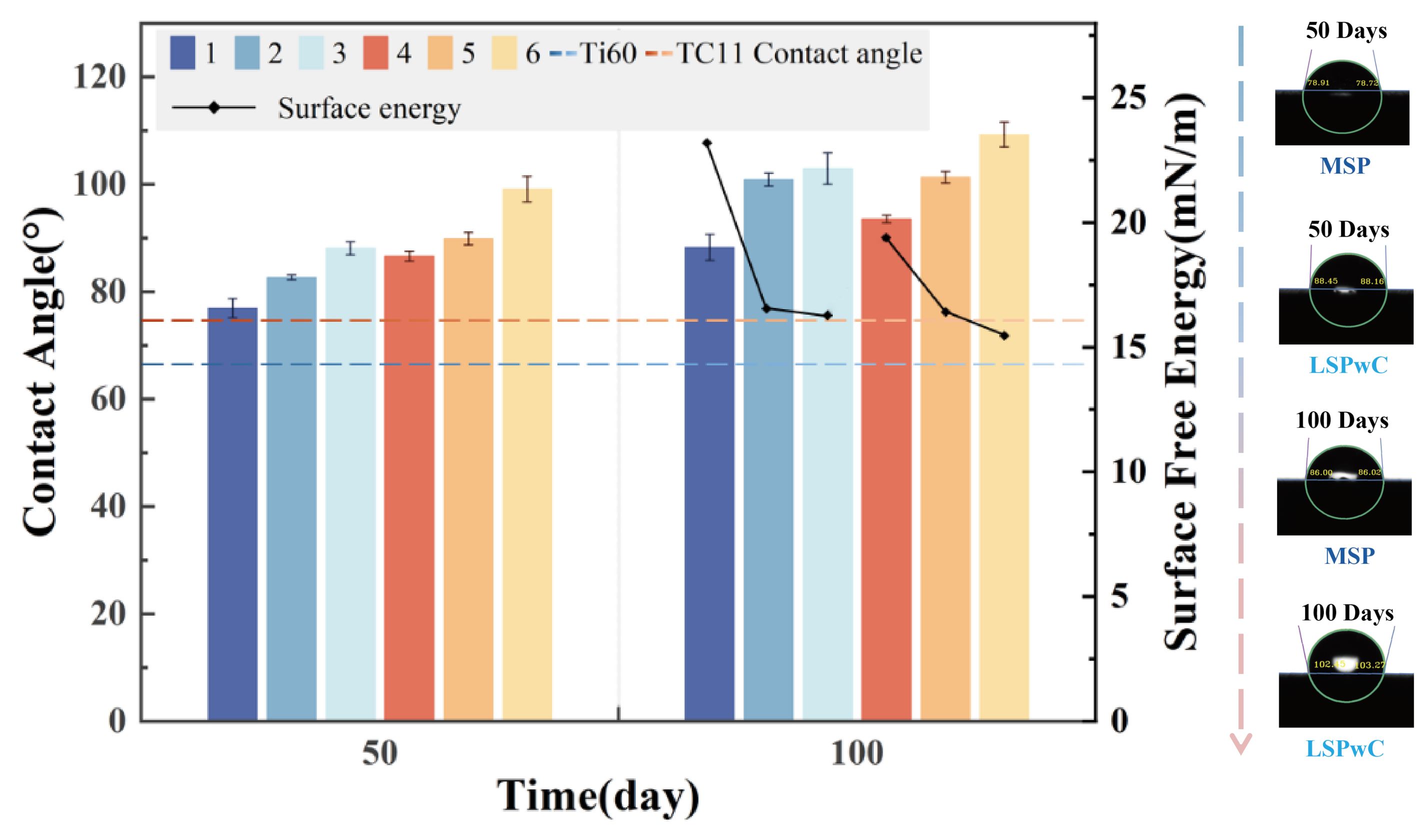
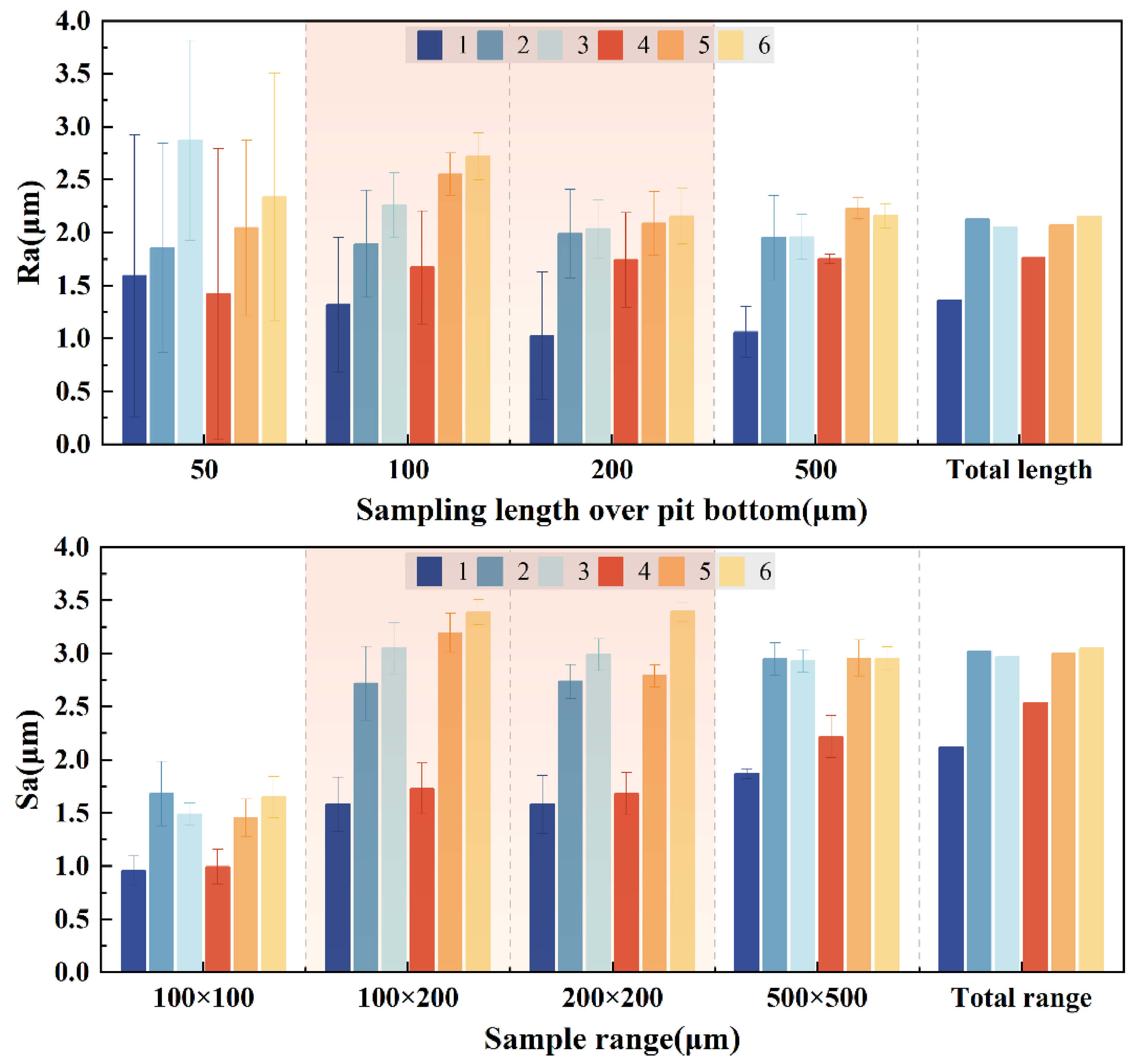


Figure 5. Roughness results under different sampling areas



Conclusions

(1) Compared with MSP, LSPwC treatment yielded more regular cyclic variations, with surface roughness of the samples increasing proportionally to laser energy.

(2) Compared with MSP, LSPwC treatment samples exhibited larger contact angles and higher hydrophobicity. Higher laser energy and density in LSPwC treatments further improved surface hydrophobicity. Surface energy was inversely correlated with wettability. Aging treatment enhanced surface hydrophobicity.

(3) Target material wettability was inversely correlated with surface roughness. The Wenzel model primarily elucidated the mechanism in MSP treatment, while Cassie–Baxter model primarily elucidated the mechanism in LSPwC treatment.

(4) Owing to the influence of surface roughness calculation formulas, the sampling range can significantly affect the obtained roughness results.

Paper

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