coatings

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Article

Supplementary Materials - Low-frictional properties of Si-DLC coatings sliding against aluminum alloy under humid conditions

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Figure S1. XPS survey spectra of the Si-DLC coatings. The Si concentrations of the TMS20, TMS50, and TMS80 coatings were quantified as 5.0, 7.7, and 14.3 at.%, respectively.

Figure S2. Variation of the coefficient of friction (COF) of the DLC and Si-DLC coatings. The sliding tests were conducted under different applied loads (25, 50, 100, and 150 N) at a relative humidity of ~90%.

Figure S3. Rockwell indentation test results of the DLC and Si-DLC coatings evaluated according to the VDI 3198 standard. Indentations were performed using a Rockwell hardness tester with a C-scale diamond indenter (cone angle: 120°, load: 1471 N, dwell time: 10 s), and the resulting damage patterns were used to comparatively assess the adhesion strength of the coatings. The TMS50 coating exhibits relatively lower adhesion compared with the other coatings.

Figure S4. Wear tracks formed on the (a) DLC-, (b) TMS20-, and (c) TMS80-deposited substrates after friction tests.

Figure S5. XPS analysis of the tribofilms formed on the aluminum alloy (A5052) balls after sliding under humid conditions (relative humidity > 90%). (a) Si content of the tribofilms for TMS20 and TMS80. (b) Corresponding SXI images of the tribofilm, indicating the analyzed areas. (c) High-resolution Si2p spectra of the tribofilms, highlighting the difference in Si signal intensity.

Figure S6. Contact angle measurements of (a) DLC-, (b) TMS20-, and (c) TMS80 coatings.

Figure S7. High-magnification SEM images of the tribofilm formed on the aluminum alloy (A5052) ball after sliding under humid conditions (relative humidity > 90%) for TMS80. (a) The tribofilm appears as discontinuous patch-like regions rather than a continuous layer, and (b-d) is accompanied by pronounced cracking and local delamination.

Table S1. Detailed deposition conditions of DLC and Si-DLC coatings.

Table S2. Roughness values of DLC and Si-DLC coatings.

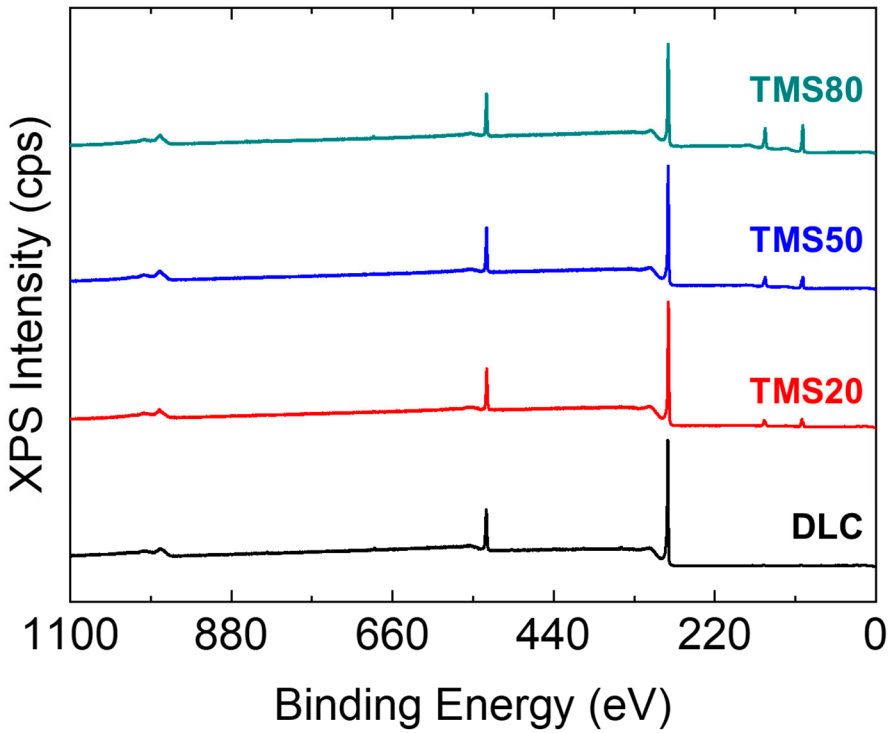


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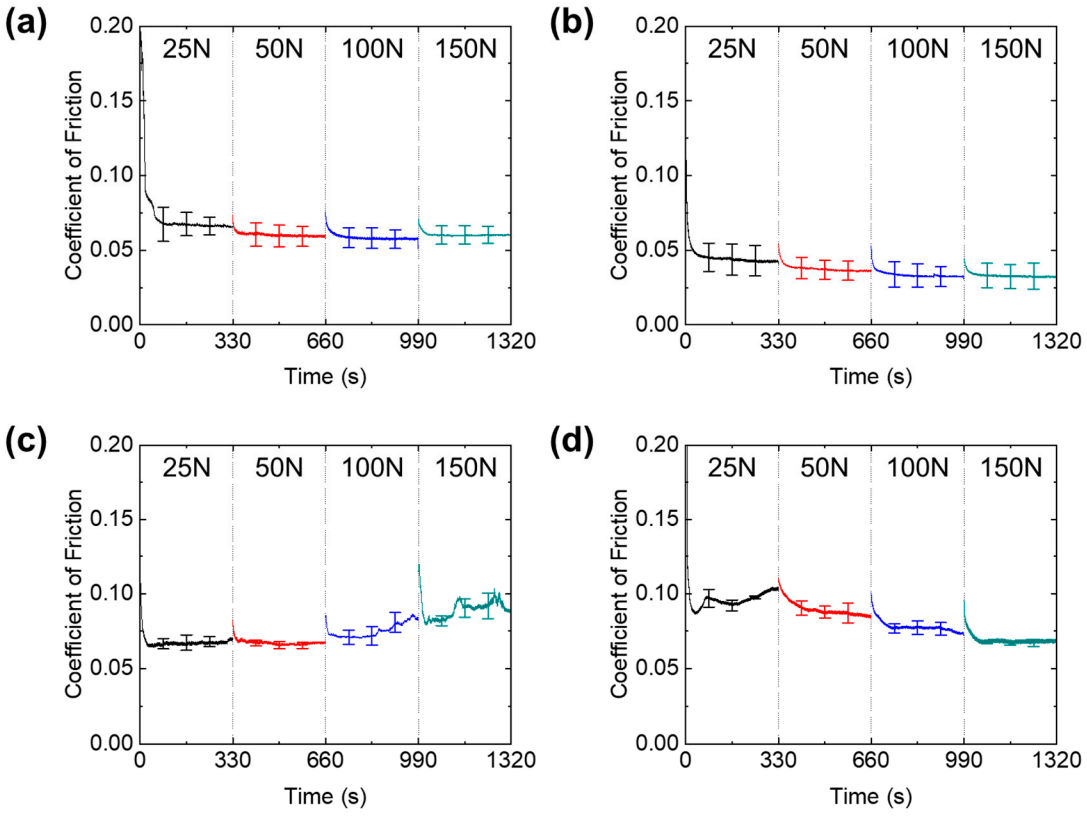


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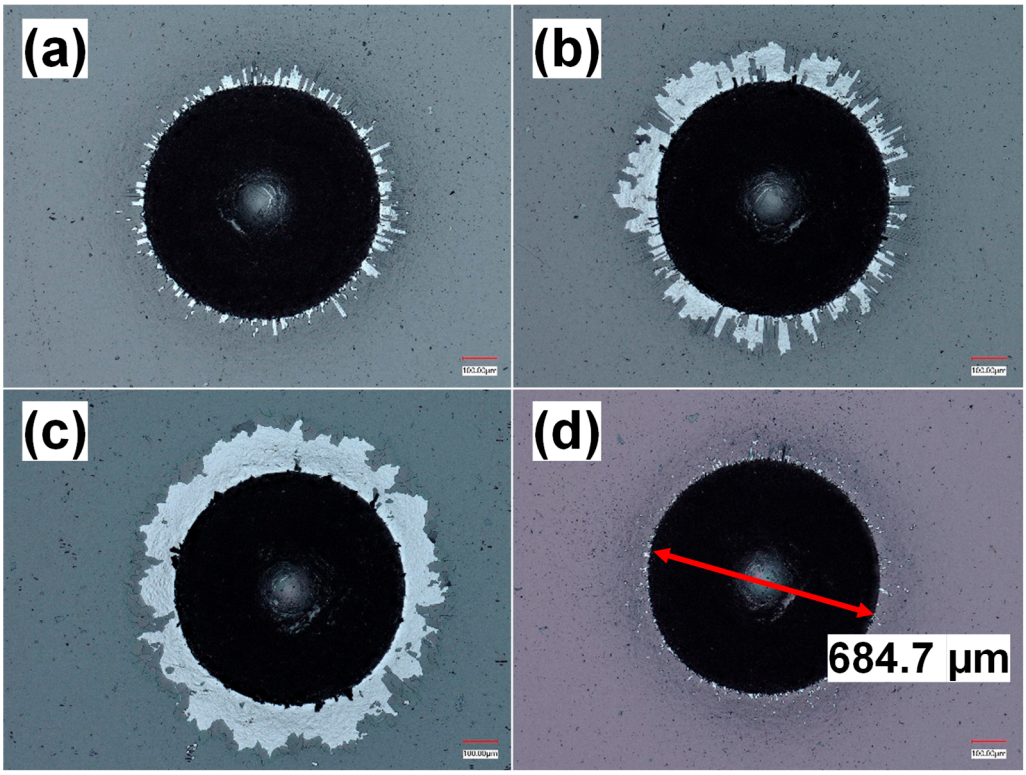


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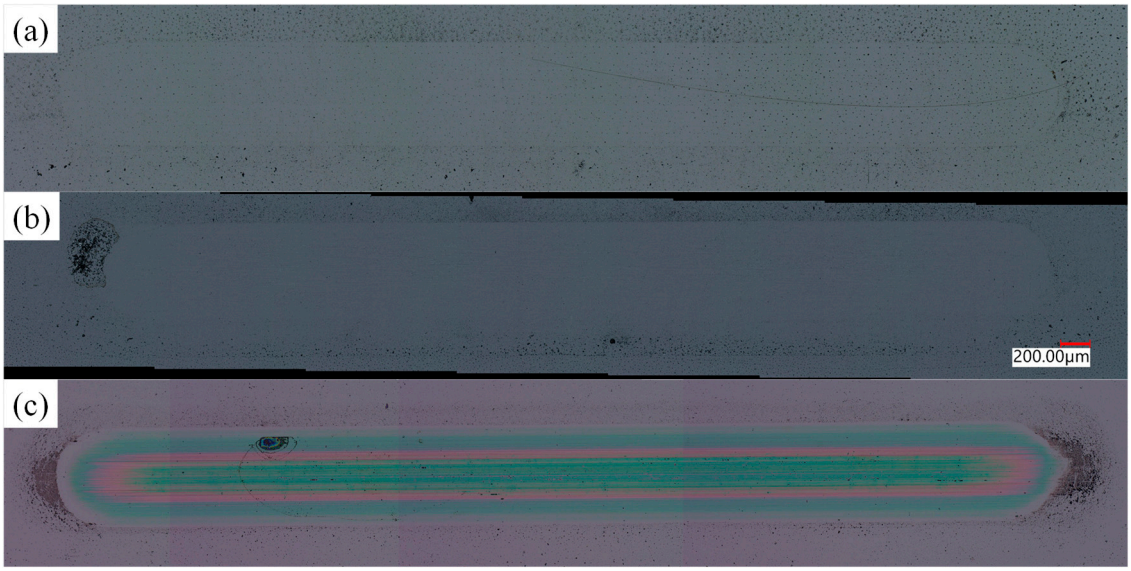


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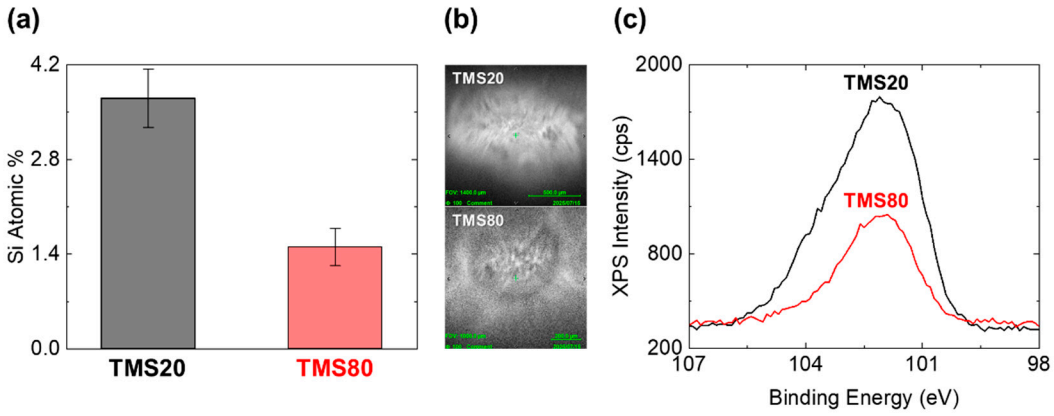


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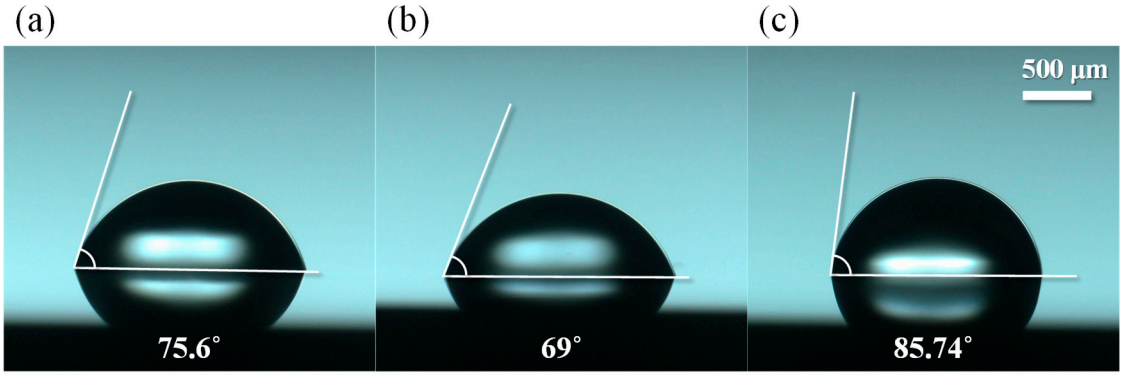


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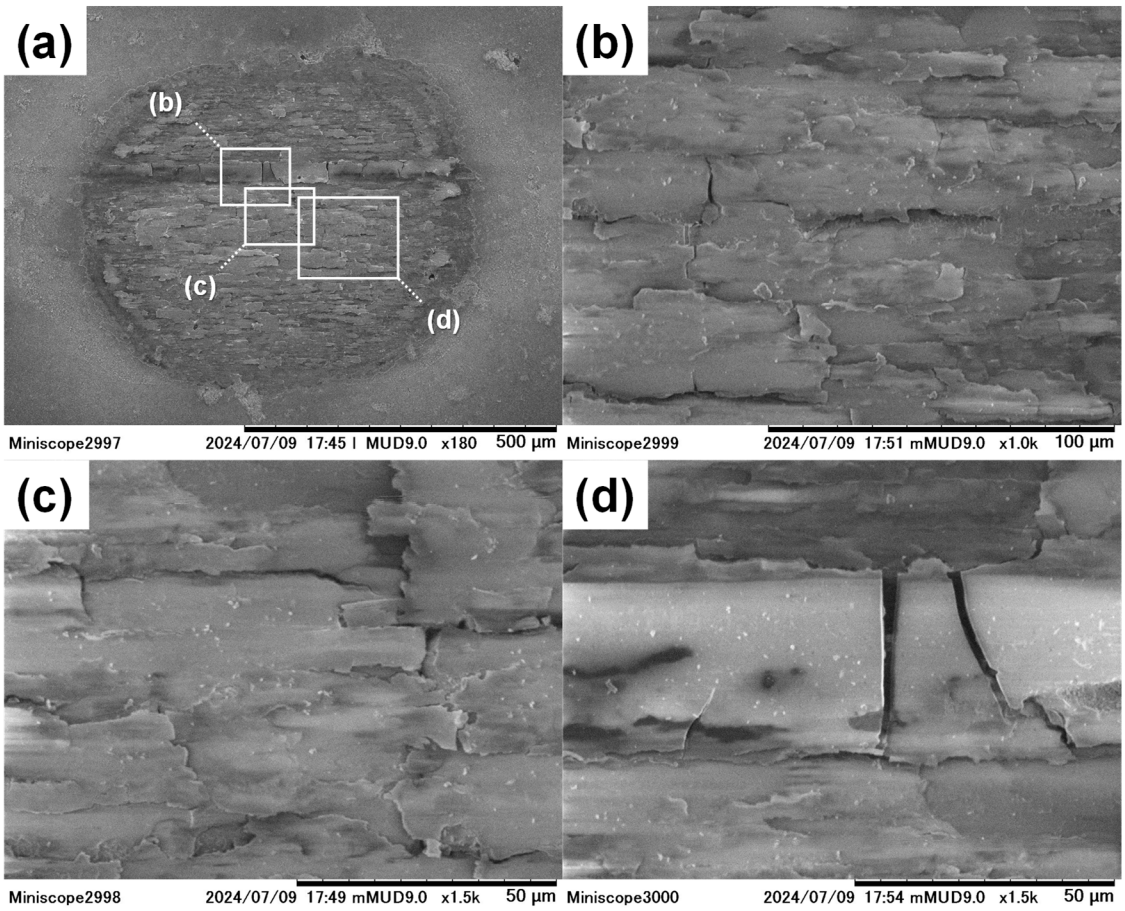


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Table S1. Detailed deposition conditions of DLC and Si-DLC coatings.

Vacuuming	Base pressure (Pa)		~1×10^{-4}
	Working pressure (Pa)		0.4
Pre-sputter	Positive	Pulse voltage (kV)	1.5
		Pulse with (μm)	5.0
	Negative	Pulse voltage (-kV)	5.0
		Pulse with (μm)	5.0
		Delay (μm)	20.0
	Frequency (Hz)		4000
	Duration (h)		1
	Precursor		Ar-H_2 10 sccm
Toplayer	Positive	Pulse voltage (kV)	1.5
		Pulse with (μm)	5.0
	Negative	Pulse voltage (-kV)	5.0
		Pulse with (μm)	5.0
		Delay (μm)	20.0
	Frequency (Hz)		4000
	Gas ratio (Toluene/TMS)	DLC	10/0 sccm
		Si-DLC	2/8, 5/5, 8/2 sccm

Table S2. Roughness values of DLC and Si-DLC coatings.

	Ra [μm]	Rq [μm]
DLC	0.027	0.034
TMS20	0.025	0.034
TMS50	0.009	0.016
TMS80	0.005	0.007