Supplementary Information (SI) for Soft Matter.
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Supplementary Information for "Quantitative rationalization of unexpectedly moderate water wettability on poly (vinyl alcohol) surfaces: Thermodynamic Evaluation and Prediction of Surface Hydrogen Bonding"

Zhuohuan Guo, Zhuoyuan Ma [*] and Dayang Wang [*]

State Key Laboratory for Inorganic Synthesis and Preparative Chemistry, College of Chemistry, Jilin University, 130012, Changchun, China

* Corresponding authors. E-mail: wangdayang@jlu.edu.cn, mzyjlu@163.com

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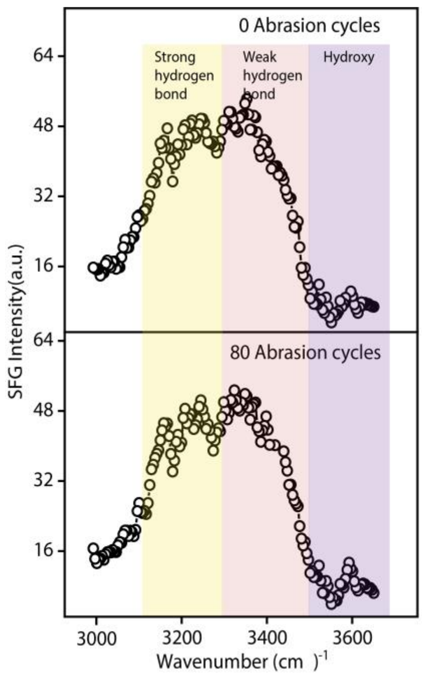

Figure S1. SFG spectra of as-prepared L_PVA$_2^{140}$ thin films before and after 80 cycles of abrasion.

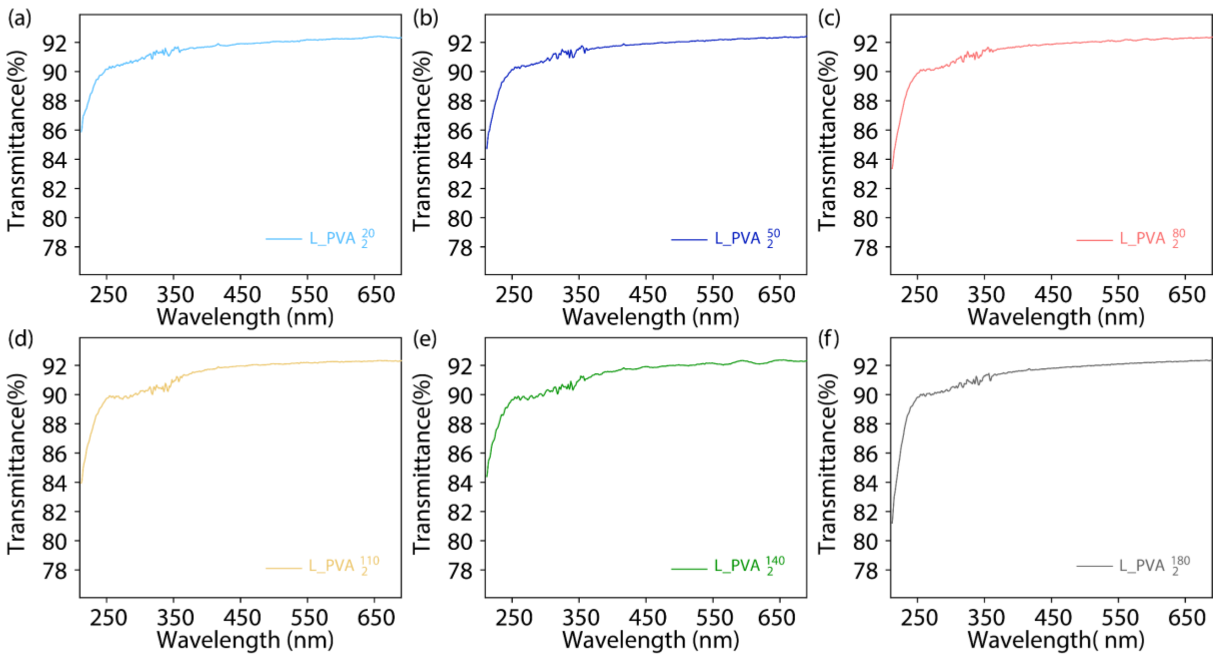

Figure S2. (a-f) UV-Vis spectra of as-prepared L_PVA$_2^{20}$, L_PVA$_2^{50}$, L_PVA$_2^{80}$, L_PVA$_2^{110}$, L_PVA$_2^{140}$ and L_PVA$_2^{180}$ thin films in the wavelength range of 200-700 nm, respectively.

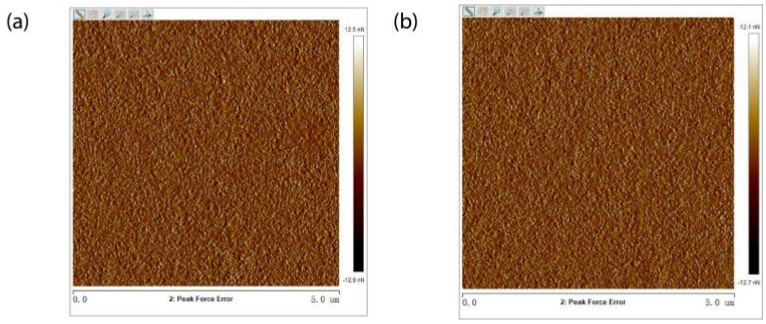

Figure S3. AFM images of as-prepared $\mathrm{L\_PVA}_2^{20}$ (a) and $\mathrm{L\_PVA}_2^{180}$ (b) thin films.

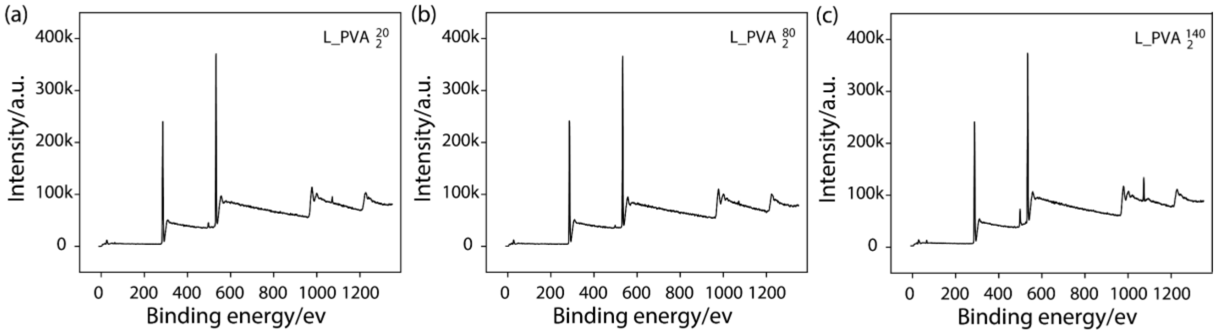

Figure S4. High-resolution XPS spectra of the survey signals of $\mathrm{L\_PVA}_2^{20}$ (a), $\mathrm{L\_PVA}_2^{80}$ (b), and $\mathrm{L\_PVA}_2^{140}$ thin films (c).

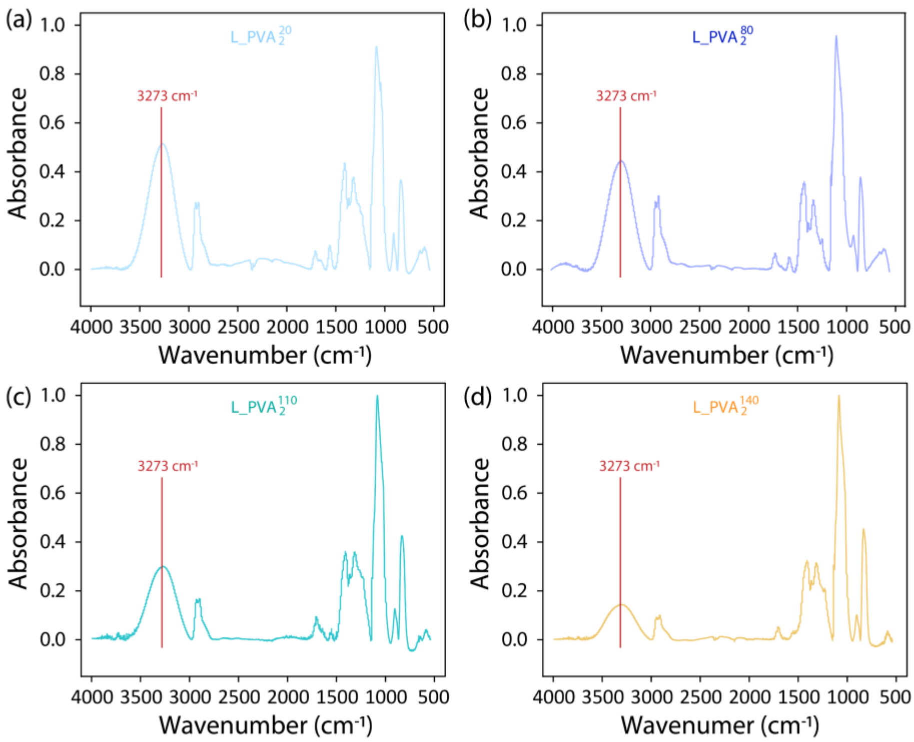

Figure S5. (a-d) ATR-FTIR spectra of as-prepared $\mathrm{L\_PVA}_2^{20}$, $\mathrm{L\_PVA}_2^{80}$, $\mathrm{L\_PVA}_2^{110}$, and $\mathrm{L\_PVA}_2^{140}$ thin films in the range of 4000-400 cm^{-1}, respectively.

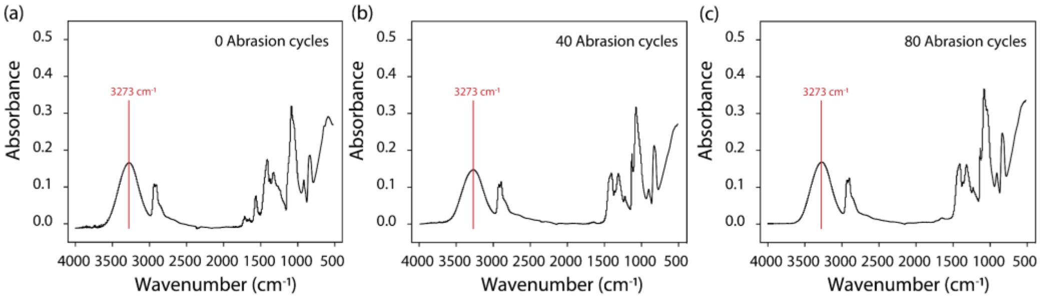

Figure S6. (a-c) ATR-FTIR spectra of as-prepared L_PVA$_{2}^{140}$ thin films after their surfaces are subjected to 0, 40 and 80 cycles of abrasion, respectively.

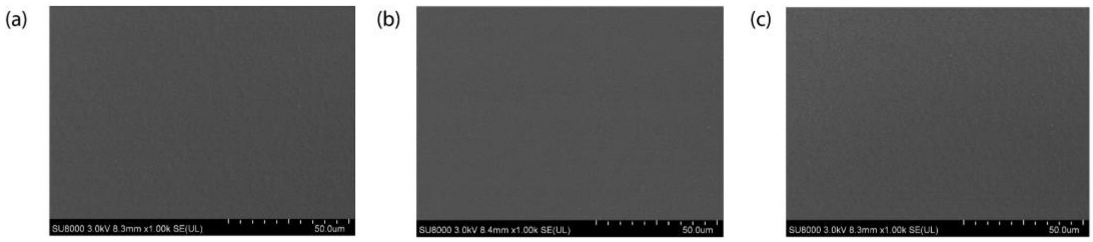

Figure S7. (a-c) SEM images of as-prepared H_PVA$_{2}^{80}$, L_PVA$_{7}^{RT}$, and M_PVA$_{G}^{RT}$ films, respectively.

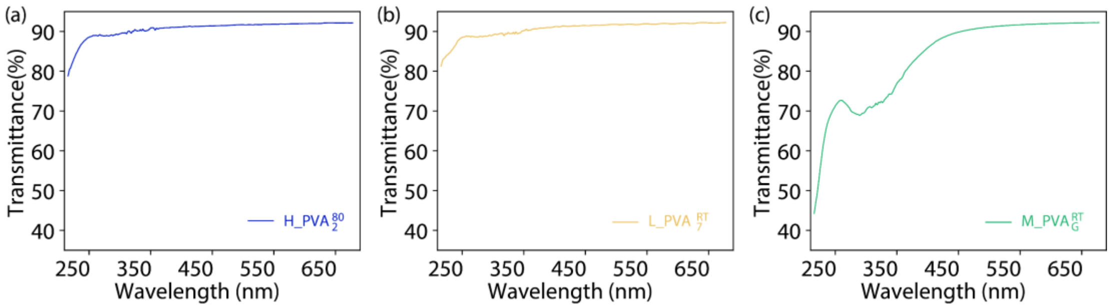

Figure S8. (a-c) UV-Vis spectra of as-prepared H_PVA$_{2}^{80}$, L_PVA$_{7}^{RT}$, and M_PVA$_{G}^{RT}$ films in the wavelength range of 200-700 nm, respectively.

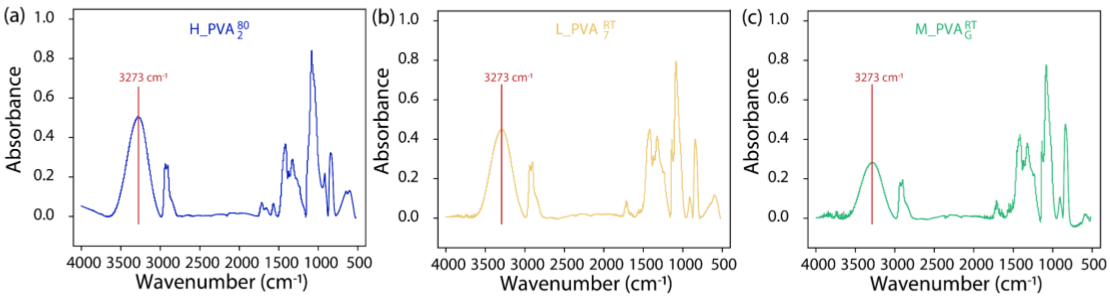

Figure S9. (a-c) ATR-FTIR spectra of H_PVA$_{2}^{80}$, L_PVA$_{7}^{RT}$, and M_PVA$_{G}^{RT}$ films in the range of 4000-400 cm^{-1}, respectively.

Table S1. Summary of the fitting parameters of ATR-FTIR spectra on $L\_PVA_2^T$, $H\_PVA_2^{80}$, $L\_PVA_7^{RT}$ and $M\_PVA_G^{RT}$ thin films.

$L\_PVA_2^T$	OH_t group				OH_g group				R^2
	peak position	Standard errors	peak area	Standard errors	peak position	Standard errors	peak area	Standard errors	
$L\_PVA_2^{20}$	3222 cm^{-1}	2.4 cm^{-1}	59.5	3.0	3356 cm^{-1}	3.3 cm^{-1}	41.7	3.0	0.9937
$L\_PVA_2^{80}$	3222 cm^{-1}	1.9 cm^{-1}	50.5	1.9	3356 cm^{-1}	2.2 cm^{-1}	39.6	1.9	0.9981
$L\_PVA_2^{110}$	3222 cm^{-1}	2.3 cm^{-1}	37.1	1.5	3356 cm^{-1}	2.7 cm^{-1}	30.0	1.5	0.9951
$L\_PVA_2^{140}$	3222 cm^{-1}	2.0 cm^{-1}	22.7	0.6	3356 cm^{-1}	2.2 cm^{-1}	42.5	0.6	0.9959
$H\_PVA_2^{80}$	3222 cm^{-1}	2.6 cm^{-1}	56.5	3.8	3356 cm^{-1}	3.0 cm^{-1}	54.0	4.6	0.9962
$L\_PVA_7^{RT}$	3222 cm^{-1}	5.0 cm^{-1}	49.8	4.7	3356 cm^{-1}	4.0 cm^{-1}	46.6	4.8	0.9953
$M\_PVA_G^{RT}$	3222 cm^{-1}	2.7 cm^{-1}	28.5	3.7	3356 cm^{-1}	3.5 cm^{-1}	24.7	2.7	0.9970

Bootstrapping Validation of $\gamma_t^{s,p*}$ and $\gamma_g^{s,p*}$ values.

Based on the determination method for $\gamma_t^{s,p*}$ and $\gamma_g^{s,p*}$ values reported in Section 3.3, Line 24, and the data listed in Table 1 (at least three sets), we applied the multivariable linear regression model in Origin to fit Equation 13 and obtained the following values that satisfy the condition: 0 mN/m < $\gamma_t^{s,p*}$ and $\gamma_g^{s,p*}$ < 50 mN/m:

For $\gamma_t^{s,p*}$: $(x_1 = 6.2\ mN/m, x_2 = 8.4\ mN/m, x_3 = 8.0\ mN/m)$

For $\gamma_g^{s,p*}$: $(x_1 = 9.0\ mN/m, x_2 = 8.5\ mN/m, x_3 = 9.8\ mN/m)$

The 95% confidence intervals for $\gamma_t^{s,p*}$ and $\gamma_g^{s,p*}$ were calculated using Equation (13), resulting in the following: $\gamma_t^{s,p*}$ 95% CI: 7.5 ± 1.5 mN/m; $\gamma_g^{s,p*}$ 95% CI: 9.1 ± 1.2 mN/m. The confidence interval formula is described as follows:

$$CI = \bar{x} \pm t \times \frac{SD}{\sqrt{n}} \quad \text{(S1)}$$

where $\bar{x}$ is the sample mean, t is the critical value from the t-distribution (2.3534), SD is the standard deviation, and n is the sample size.