Electronic Supplementary Information

Investigation into self-assembled collagen arrays guided by surface properties of polyimide films

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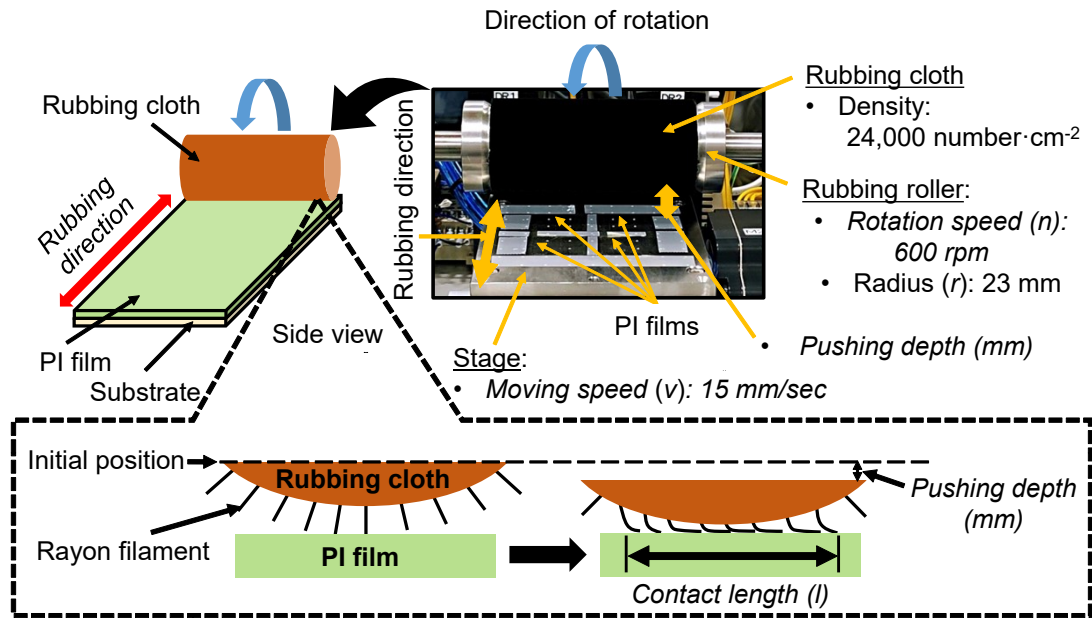Tel: +81-258-47-9345; Fax: +81-258-47-9300, E-mail: tagaya@mst.nagaokaut.ac.jp

Figure S1

Direction of rotation

Rubbing cloth

Rubbing direction

Rubbing direction

Rubbing direction

PI films

Side view

Rubbing cloth
- Density:
  24,000 number·cm^{-2}

Rubbing roller:
- *Rotation speed (n):
  600 rpm*
- Radius (*r*): 23 mm

- *Pushing depth (mm)*

PI film

Substrate

Stage:
- *Moving speed (v): 15 mm/sec*

Initial position

Rubbing cloth

Rubbing cloth

Pushing depth
(mm)

Rayon filament

PI film

Contact length (*l*)

Figure S1. Illustration of the rubbing treatment equipment and the photograph.
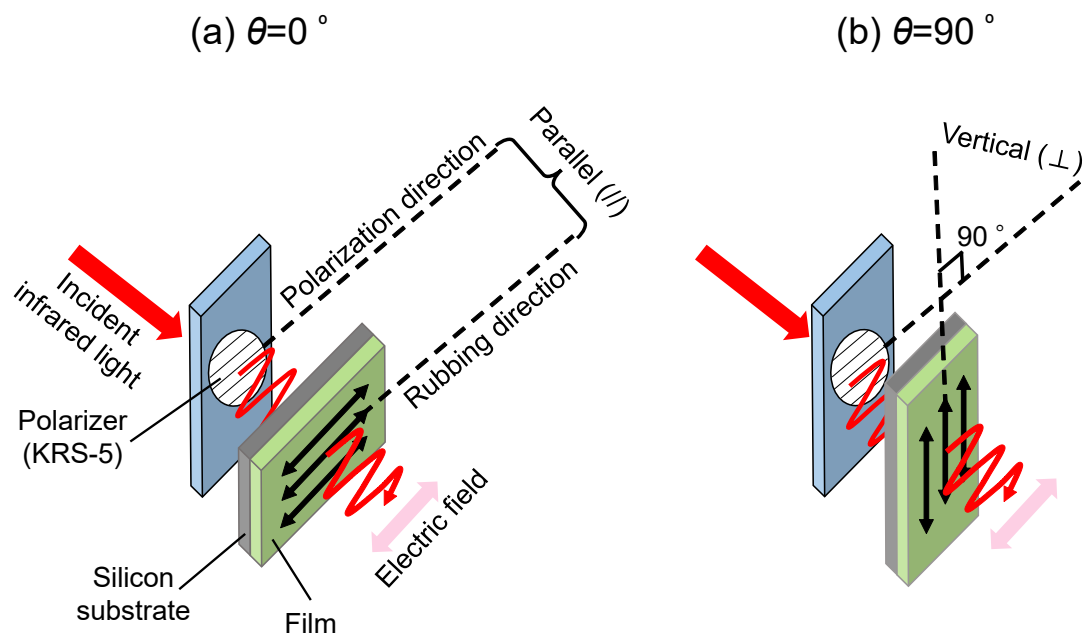
Figure S2

Fig. S2. Illustration of the polarized FT-IR measurement systems. (a) the state of "polarization direction // rubbing direction" was named as "θ=0 °", and (b) the state of "polarization direction ⊥ rubbing direction" was named as "θ=90 °". The θ value was changed from 0 ° to 90 °.

Equation (S1)

The root mean square roughness (R_{rms} (nm)) was calculated by the following **Equation (S1)**.

$$R_{rms} = \sqrt{\frac{1}{n}\sum_{n=1}^{n}(h(x_i) - h)^2}$$

(S1)

Here, n is the number of measurement points, $h(x_i)$ is the height at the measurement point x_i, and h is the average height.
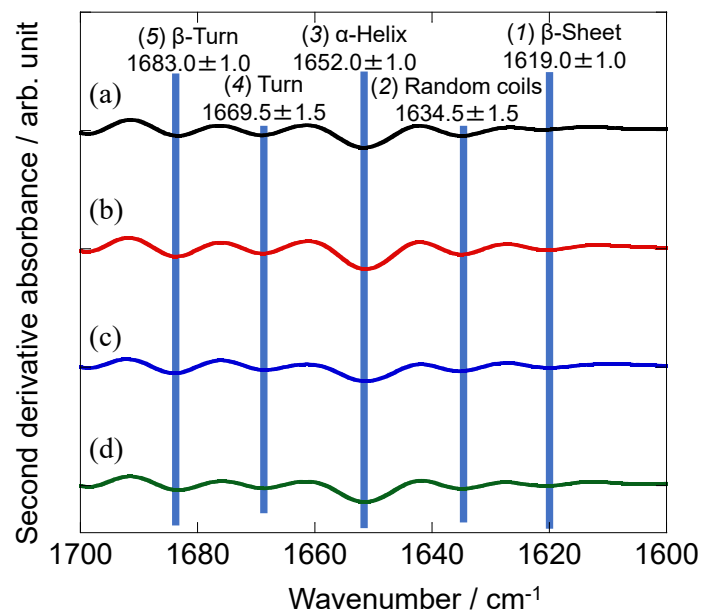
Figure S3

Fig. S3. The second derivative spectra of amide I bands of (a) PI-Col-M, (b) PI-R-Col-M, (c) PI-Col-F and (d) PI-R-Col-F, and the detailed assignments (*1*)−(*5*) were described in the experimental section.
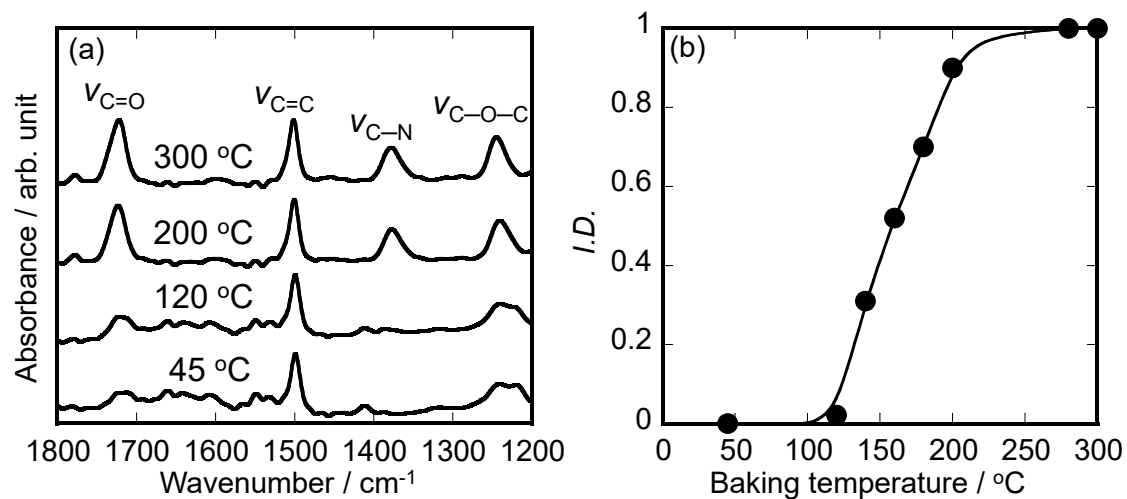
Figure S4

Fig. S4. (a) Representative FT-IR spectra of the PI films and (b) their *I. D.* values with the baking temperature in the range of 45~300 °C.
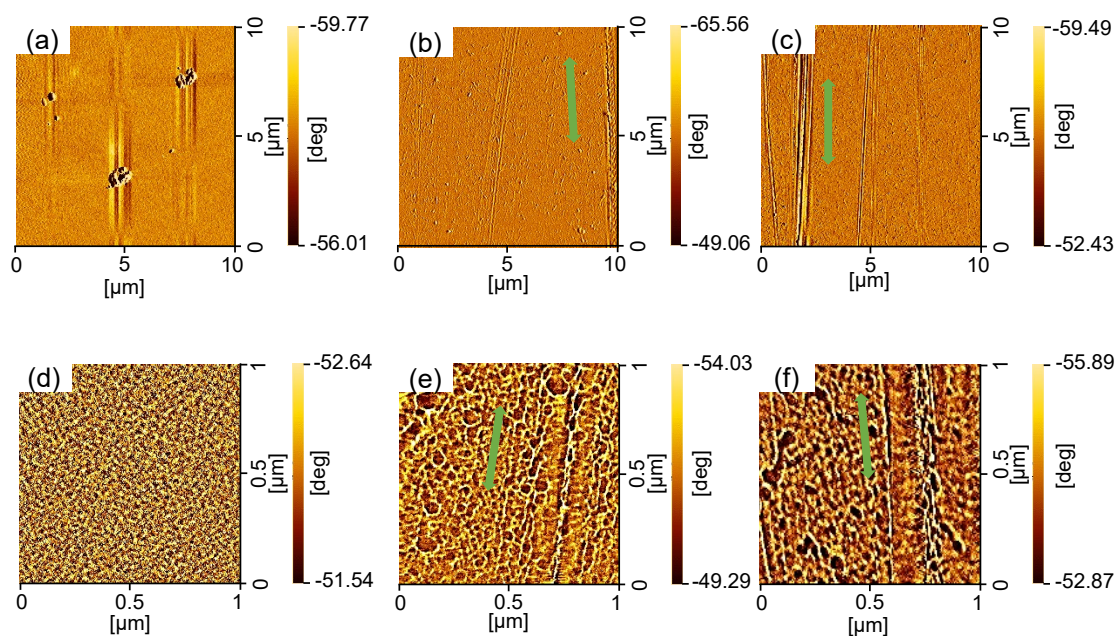
Figure S5

Fig. S5. Representative phase–shift images of the PI films treated with the *R.S.* values of (a, d) 0, (b, e) 2.4 and (c, f) 3.3 m at the observation area of (a~c) 10×10 μm^2 and (d~f) 1×1 μm^2, which correspond to the topographic images in **Fig. 2**. The green arrows indicate the rubbing directions.
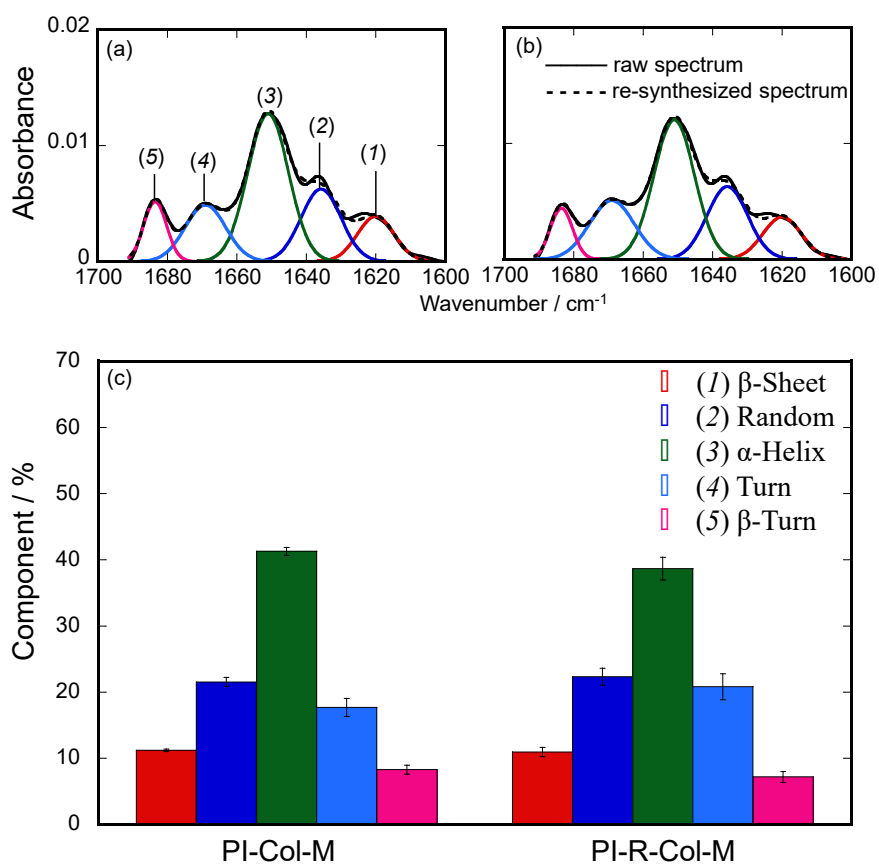
Figure S6

Fig. S6. FT-IR spectral deconvolution results of the amide I bands of Col molecules for (a) PI-Col-M and (b) PI-R-Col-M, where (c) the secondary structural components ratios of (*1*) β-Sheet, (*2*) Random, (*3*) α-Helix, (*4*) Turn and (*5*) β-Turn were calculated (n=3, mean ± SD).
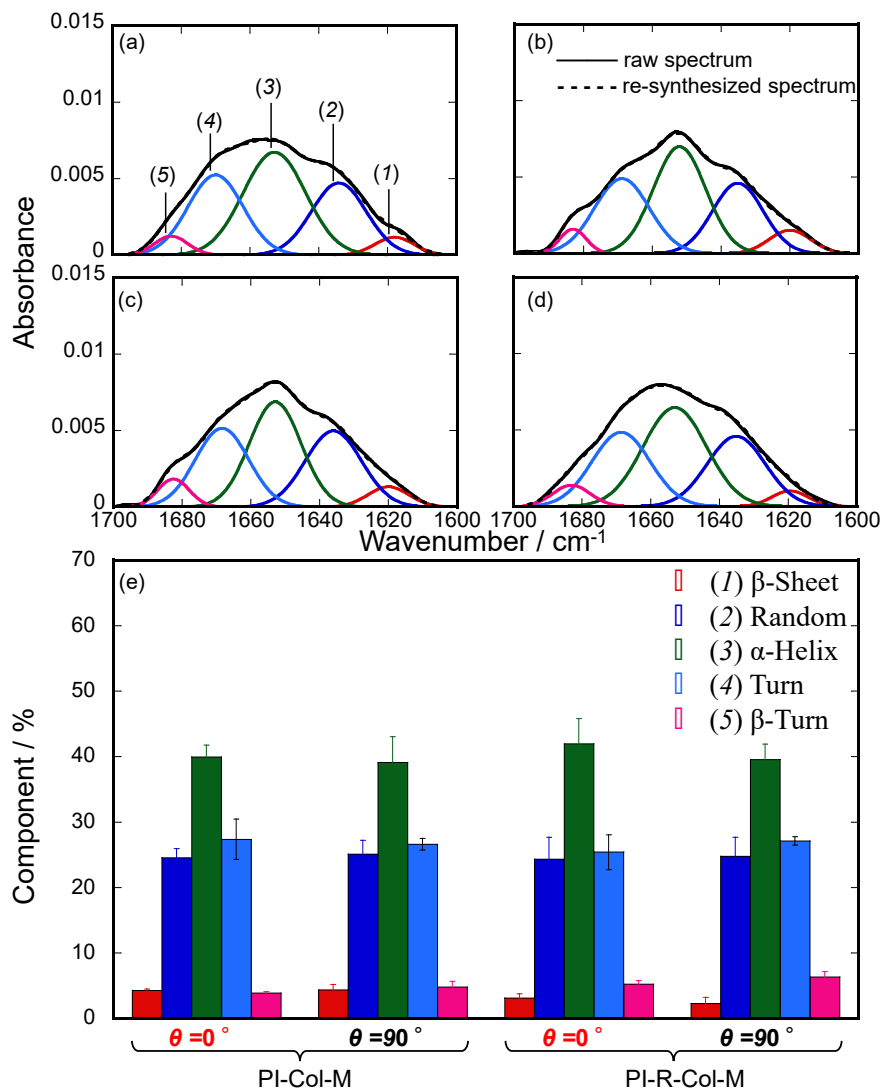
Figure S7

Fig. S7.   Polarized FT-IR spectral deconvolution results of the amide I bands of Col molecules for (a, c) PI-Col-M and (b, d) PI-R-Col-M in the case of (a, b) "θ = 0 °" and (c, d) "θ = 90 °" where (e) the secondary structural component ratios of (*1*) β-Sheet, (*2*) Random, (*3*) α-Helix, (*4*) Turn and (*5*) β-Turn were calculated (n=3, mean ± SD). Here, the state of "polarization direction // rubbing direction" was named as "θ = 0 °" and that of "polarization direction ⊥ rubbing direction" was "θ = 90 °".
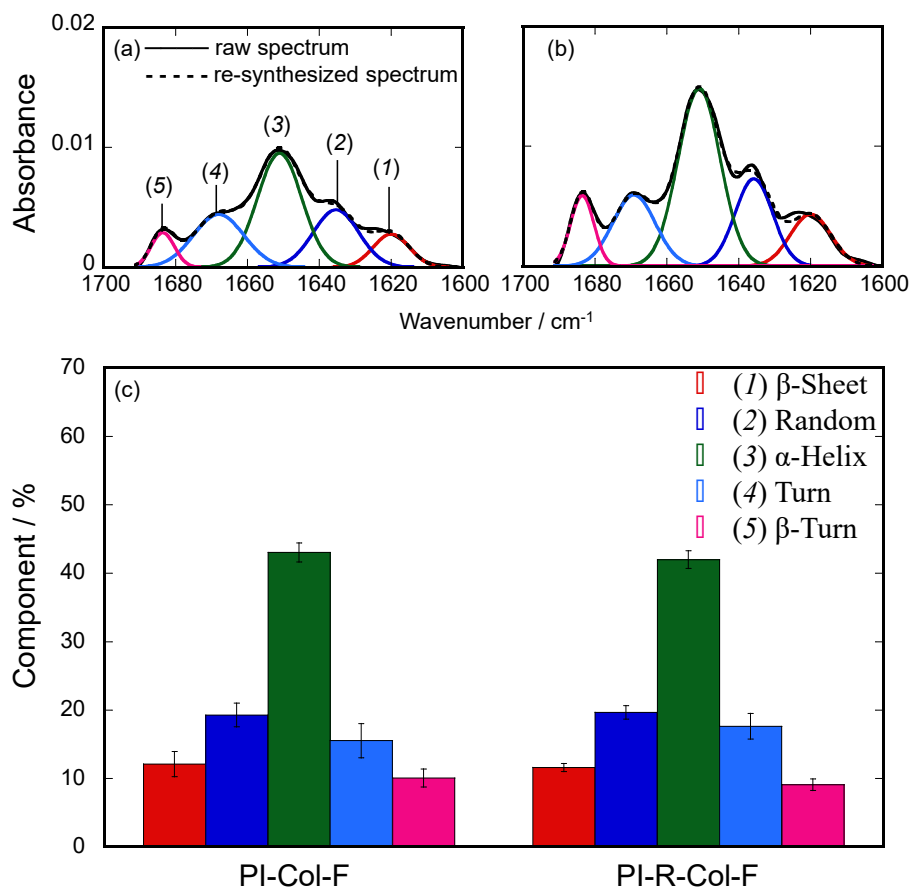
Figure S8

Fig. S8. FT-IR spectral deconvolution results of the amide I bands of Col fibrils for (a) PI-Col-F and (b) PI-R-Col-F, where (c) the secondary structural components ratios of (*1*) β-Sheet, (*2*) Random, (*3*) α-Helix, (*4*) Turn and (*5*) β-Turn were calculated (n=3, mean ± SD).
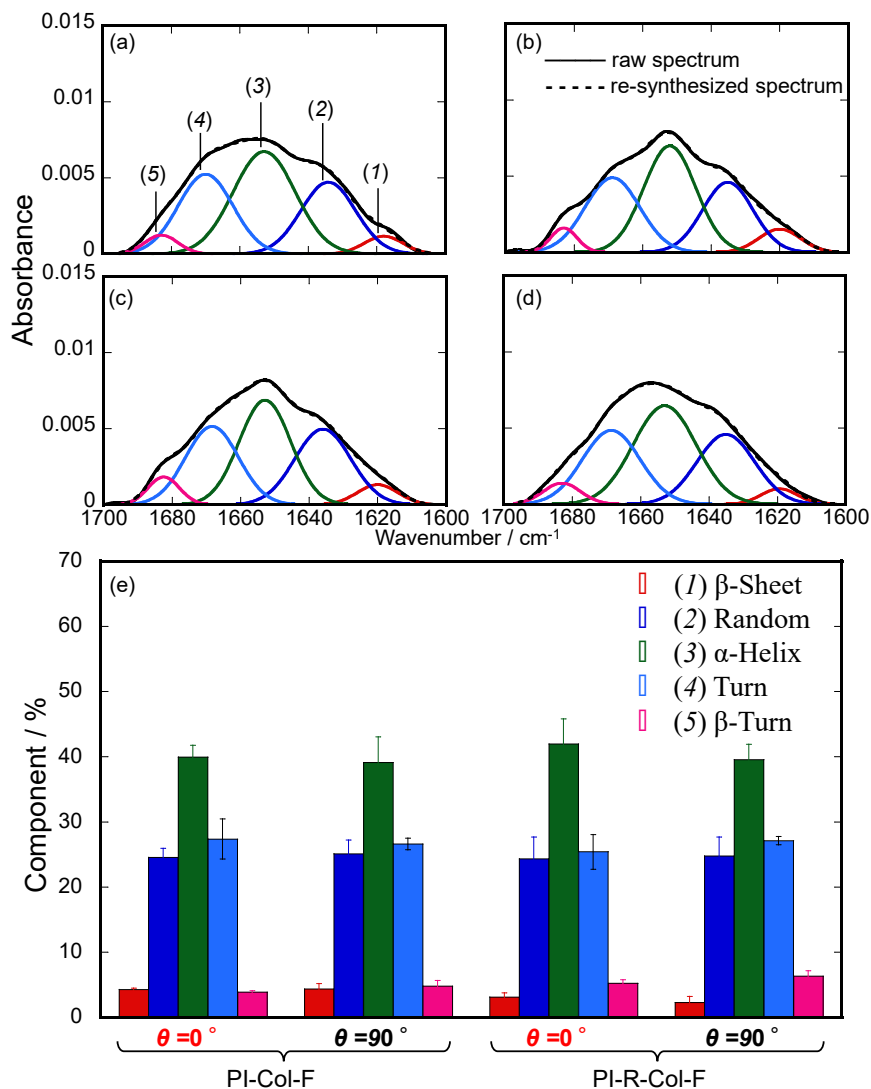
Figure S9

Fig. S9.   Polarized FT-IR spectral deconvolution results of the amide I bands of Col fibrils
for (a, c) PI-Col-F and (b, d) PI-R-Col-F in the case of (a, b) "θ = 0 °" and (c, d) "θ = 90 °",
where (e) the secondary structural component ratios of (*1*) β-Sheet, (*2*) Random, (*3*) α-Helix,
(*4*) Turn and (*5*) β-Turn were calculated (n=3, mean ± SD). Here, the state of "polarization
direction // rubbing direction" was named as "θ = 0 °" and that of "polarization direction ⊥
rubbing direction" was "θ = 90 °".