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# Supporting Information

# Large-scale fabrication of translucent, stretchable and durable superhydrophobic composite films

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# Figure S1

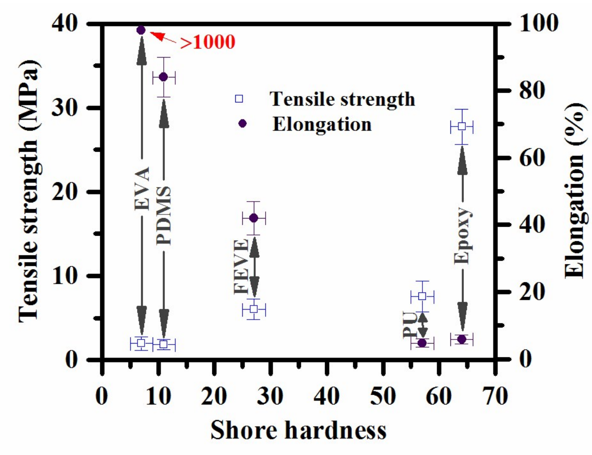

**Figure S1** The tensile strength, elongation and Shore hardness from different pure resins.

# Figure S2

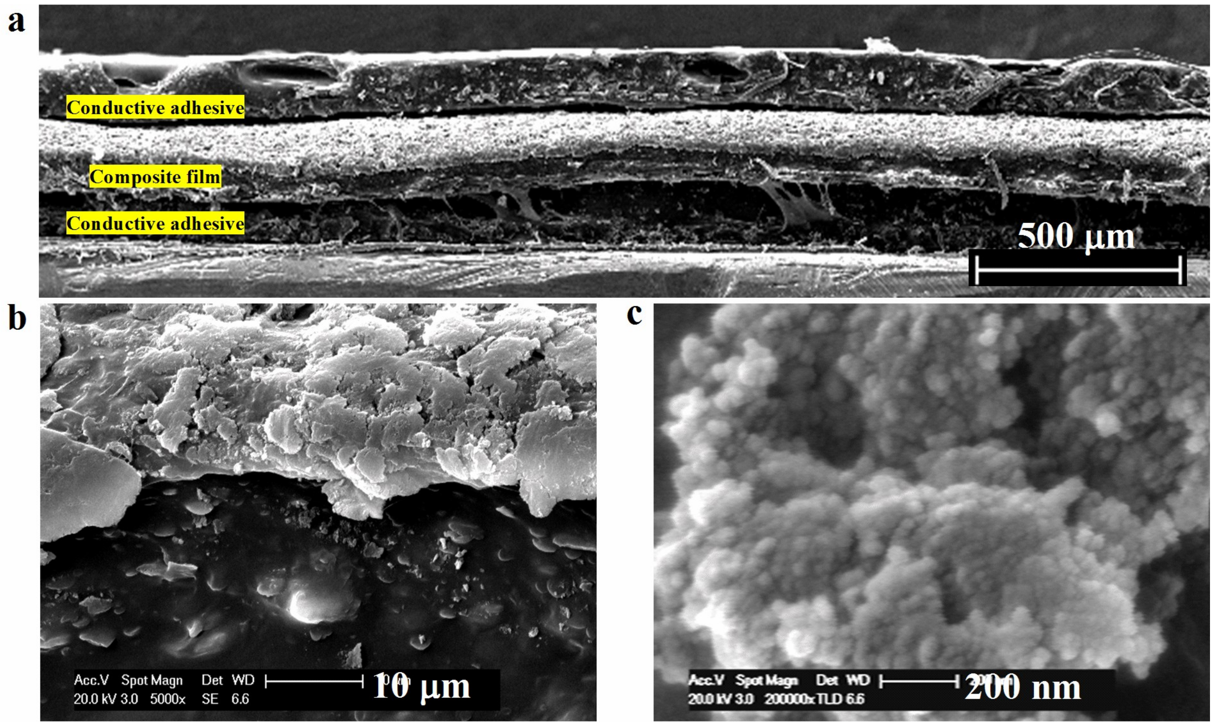

**Figure S2** FESEM images in different magnification from the cross-section of the composite superhydrophobic film.

# Figure S3

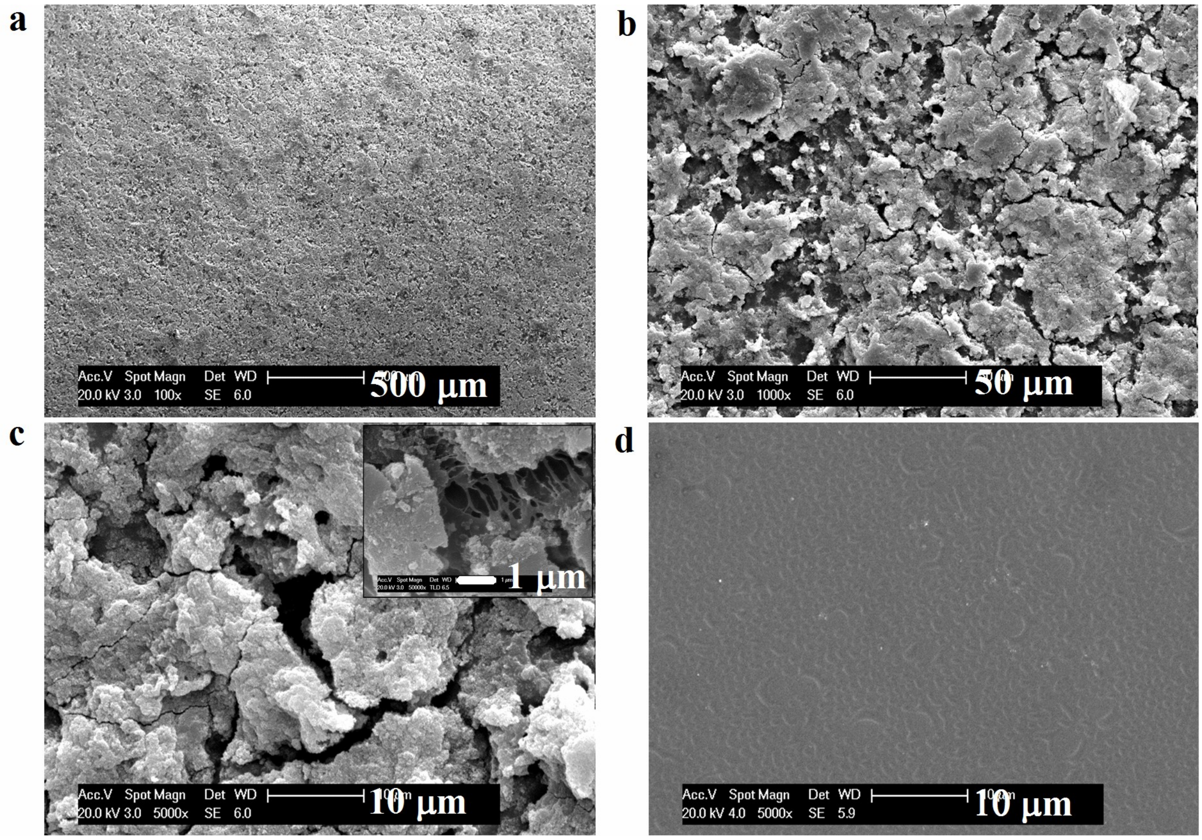

**Figure S3** FESEM images in different magnification from the surface of **a-c)** composite superhydrophobic film and **d)** composite resin (without SNPs coating).

# Figure S4

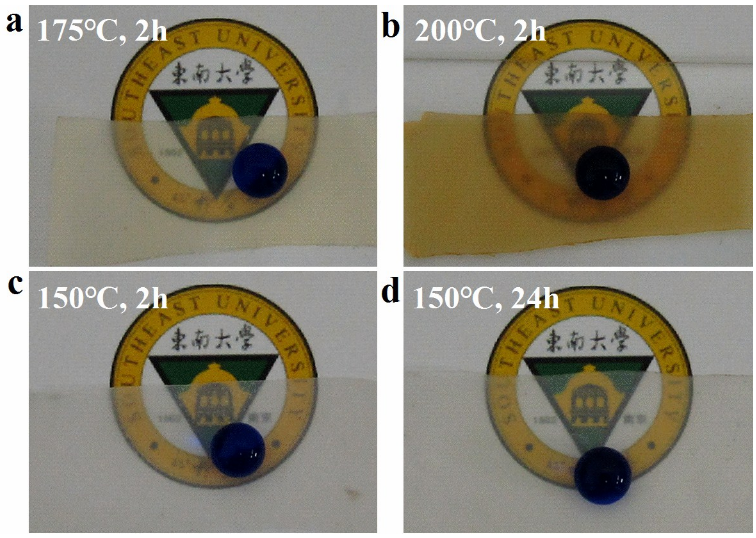

**Figure S4** Optical photographs of the composite superhydrophobic films to exhibit the color and superhydrophobicity after treatment at different condition: **a)** 175 ℃ for 2 h, **b)** 200 ℃ for 2 h, **c)** 150 ℃ for 2 h and **d)** 150 ℃ for 24 h.

# Figure S5

**Figure S5** The composite superhydrophobic film become stiff after immersing it in the liquid nitrogen.

## Figure S6

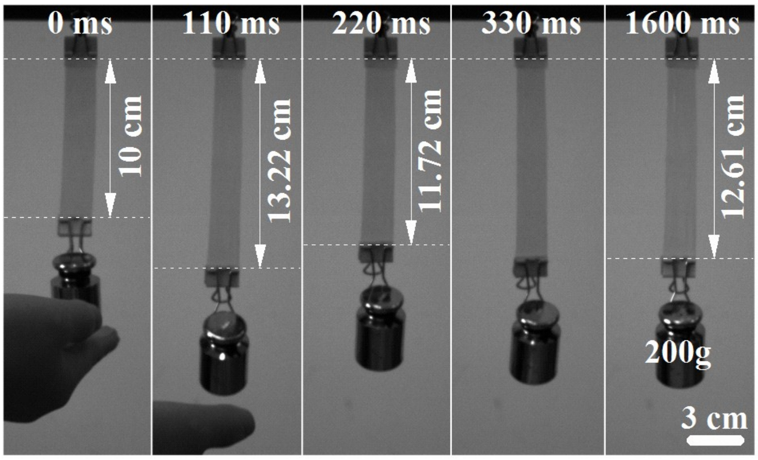

**Figure S6** Time-lapse photograph of the composite superhydrophobic film suspending a weight of 200 g from initial position. At 110 ms, the film is in the longest state (13.22 cm). Then the film began to shrink and up to the shortest state (11.72 cm) at 220 ms. After 1600 ms, the film reaches equilibrium state with length of 12.61 cm.

# Figure S7

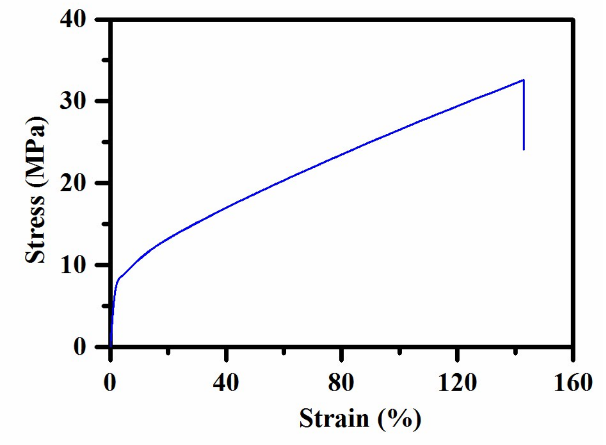

**Figure S7** Stress–strain curves of the enhanced film, which was obtained using a transparent tape to bond the composite superhydrophobic film.

# Figure S8

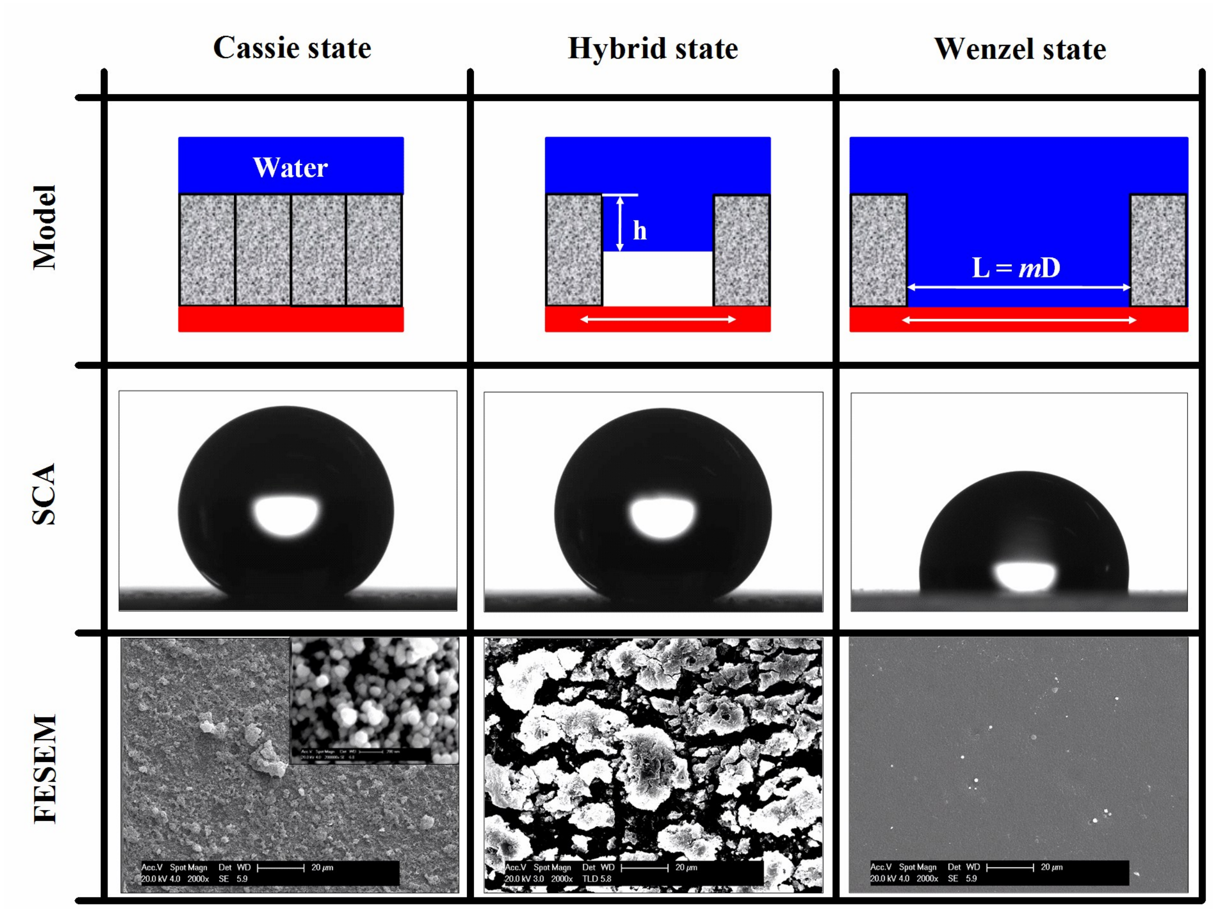

**Figure S8** The evolutionary process of the wettability of water from Cassie to Wenzel state on the film under tensile environment.

# Figure S9

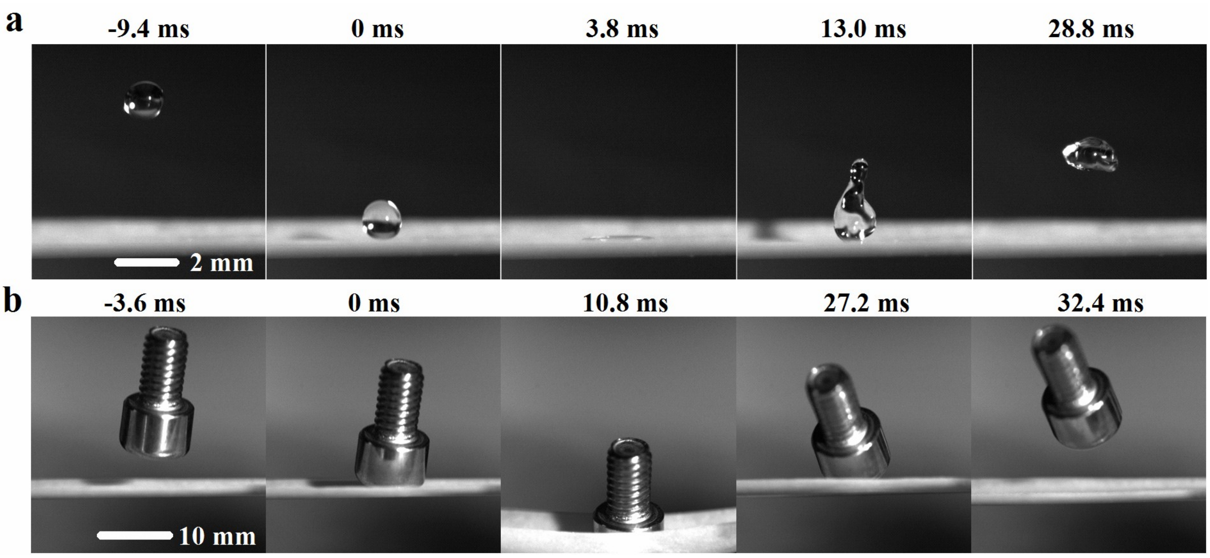

**Figure S9** Time-lapse photographs of **a)** water droplets with volume of 10 μL or **b)** weights with mass of 10 g perpendicularly bouncing the superhydrophobic composite films by free fall from 10 cm height.

# Figure S10

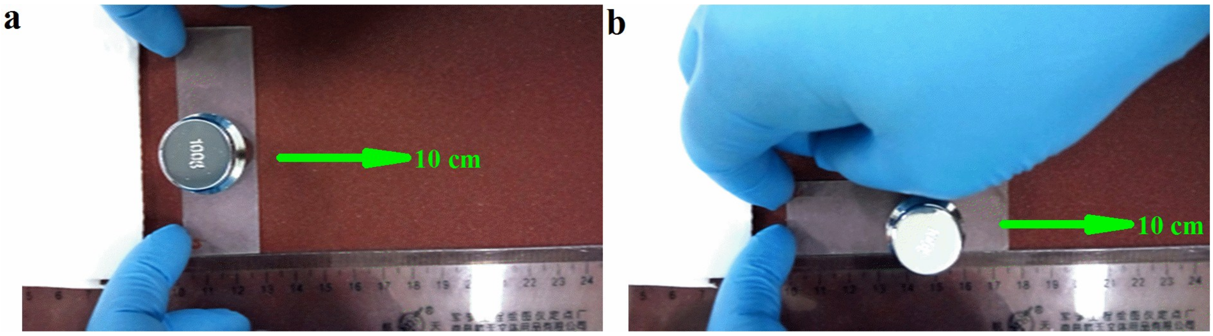

**Figure S10** Optical photographs for demonstration of one cycle of the sandpaper abrasion test.

## Videos

**Video S1** The composite superhydrophobic film could be easily pulled off on the glazed tile.

**Video S2** The composite superhydrophobic film was tailored by a common paper knife according to formulary requirement.

**Video S3** After immersing the composite superhydrophobic film in the liquid nitrogen, its superhydrophobicity and flexibility were still sustained when it softened again.

**Video S4** The tension process of the composite superhydrophobic film after suspending of a weight of 200 g from initial position.

**Video S5** The composite superhydrophobic film could back to normalcy without any deformation and damage after stretching with strain of about 20 %.

**Video S6** The bouncing process of water droplet with size of 2.1 mm on the stretchy film and rigid glass slide treated by SNPs coating.

**Video S7** Various man-made destructions by finger-wipe, single-hand-grasp, both-hands-rub and both-hands-kneading on the composite superhydrophobic film.

**Video S8** The antifouling process of sludge water on the composite superhydrophobic film.

**Video S9** Self-cleaning property was demonstrated on the composite superhydrophobic film, using the droplets to remove soil and dust.

## Modeling calculation and analysis

Under Cassie state,

$$\cos\theta_C = f_C(\cos\theta_0 + 1) - 1 \qquad (1)$$

$f_C$ was defined as solid–liquid contact area fraction on roughened surface and $\theta_0$ is the intrinsic contact angle on plane surface. In this paper, we have assumed that the SNPs coating was treated as a superhydrophobic plane. Therefore, the SNPs protuberances could be regard as separated microscale square columns on the resin. Under tensile state, the square columns were separated to form a patterned composite surface and their relative geometrical parameters were labeled as side length (D), height (H) and side-to-side distance (L). The strain (ε) of the composite superhydrophobic film was defined as $\varepsilon = L/D$. Based on this, the intrinsic contact angle was replaced by the apparent contact angle on SNP surface ($\theta_0$ = 162.1°) and $f_c$ could be defined as following:

$$f_T = \frac{D^2 + 4hD}{(L+D)^2} = \frac{1 + 4h/D}{(\varepsilon+1)^2} \qquad (2)$$

The water drops (with diameter $D_0 \gg L$) turned to the Wenzel state from the apparent Cassie state on the stretched film when $L \geq mD$. In order to simplify calculating, another assumption was presented in here that stipulated the relationship as following:

$$h = \frac{L}{mD}H = \frac{\varepsilon}{m}H \qquad (3)$$

According to the experimental data from SEM image analysis, we have selected *H=2D* in this paper. Thus, the contact angles ($\theta$) of on the hybrid state film ($0 < \varepsilon < m$) could be calculated by following formula:

$$\cos\theta = \frac{1 + \frac{8\varepsilon}{m}}{(\varepsilon+1)^2}(\cos\theta_0 + 1) - 1 \qquad (4)$$

Here, we take a derivative with respect to strain (ε),

$$\cos \acute{\theta} (\varepsilon) = \frac{\frac{8}{m} - 2 - \frac{8}{m}\varepsilon}{(\varepsilon + 1)^3}(\cos \theta_0 + 1) \qquad (5)$$

When $m > 4$, $\cos \acute{\theta} (\varepsilon) < 0$, $\theta$ monotonically increasing.

When $m < 4$, using $\cos \acute{\theta} (\varepsilon) = 0$, thus $\varepsilon = 1 - \frac{m}{4}$. Therefore, when $\varepsilon < 1 - \frac{m}{4}$, $\cos \acute{\theta} (\varepsilon) < 0$, $\theta$ monotonically decreasing, when $\varepsilon > 1 - \frac{m}{4}$, $\cos \acute{\theta} (\varepsilon) > 0$, $\theta$ monotonically increasing.

Accordingly, we draw the curve of the relationship between apparent contact angle (*θ*) and strain (ε) in **Figure α** using *H* = 2*D*, m = 2-4.

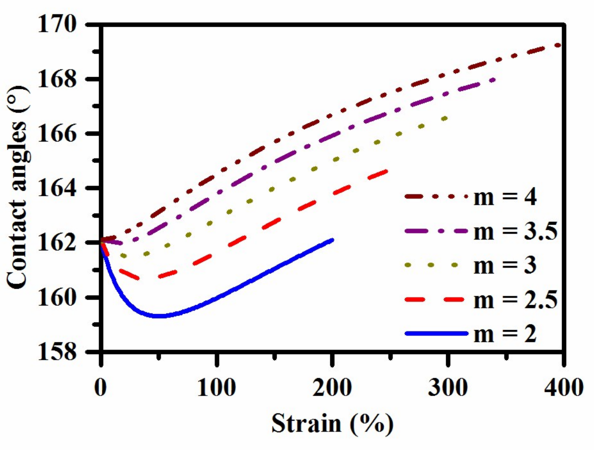

**Figure α** Relationship between the water apparent contact angles and strain calculated by H = 2D and *m* = 2-4. Based on the curve characteristics of $\theta_T(\varepsilon)$, the contact angles firstly manifest decreasing tendency with the strain, and then relatively slowly increase after beyond the peak-valley value of (1-*m*/4).

Under Wenzel state, $L > mD$ $(\varepsilon > m)$:

$$\cos \theta_W = r_W(f_1 \mathrm{r}_1 \cos \theta_{f1} + f_2 r_2 \cos \theta_{f2}) \qquad (6)$$

where $r_W$ is roughness factor on microscale, $f_1$ and $f_2$ are solid–liquid contact area fraction on microscale ($f_1 + f_2$=1), $r_1$ and $r_2$ are roughness factor of resin and SNP coating on nanoscale, $\theta_f$ and $\theta_{f2}$ are apparent contact angle of water on a flat resin and SNP surface.

$$r_W = \frac{(L + D)^2 + 4HD}{(L + D)^2} = 1 + \frac{4H/D}{(\varepsilon + 1)^2} \qquad (7)$$

$$f_1 = \frac{(L+D)^2 - D^2}{(L+D)^2 + 4HD} = \frac{(\varepsilon+1)^2 - 1}{(\varepsilon+1)^2 + 4H/D} \tag{8}$$

$$f_2 = \frac{D^2 + 4HD}{(L+D)^2 + 4HD} = \frac{1 + 4H/D}{(\varepsilon+1)^2 + 4H/D} \tag{9}$$

Using $H$=2$D$, $\theta_{f1}$=95°, $\theta_{f2}$=117°, $r_1$=1, $r_2$=2.7, the equations (6) could be written as follows:

$$\cos\theta_W = -0.087 - \frac{10.945}{(\varepsilon+1)^2} \tag{10}$$