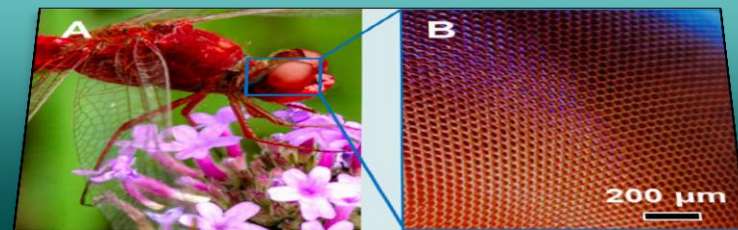


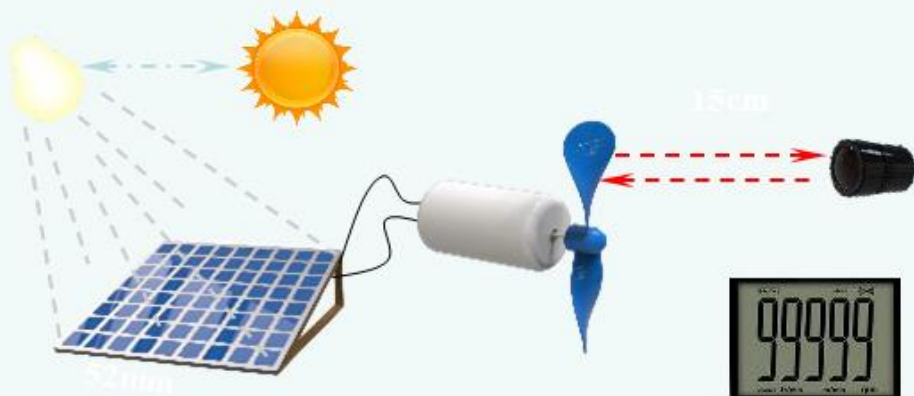


INTERNATIONAL SOCIETY OF
BIONIC ENGINEERING



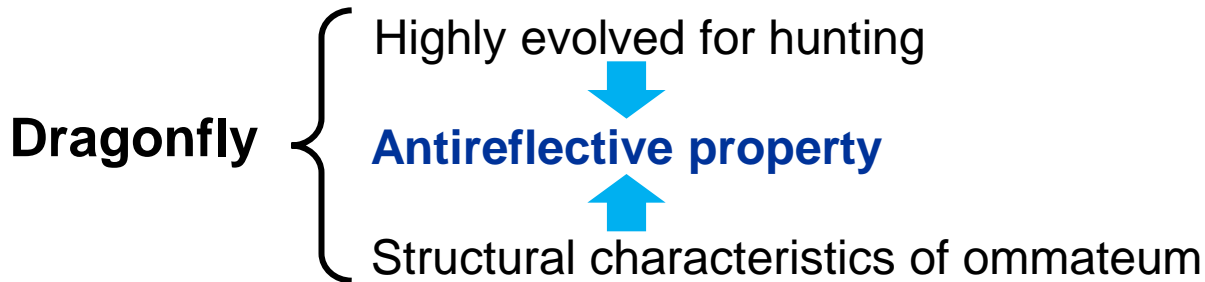
Bioinspired omnidirectional antireflective film with mechanical durability

From ommateum to solar energy collection

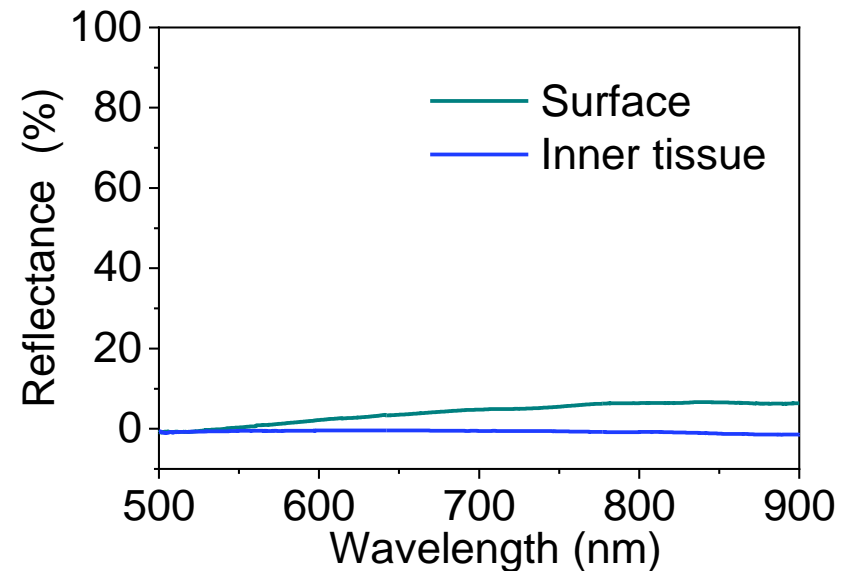


The case was provided by the
Individual Member of ISBE
(Shichao Niu, Jilin University)

1. Biological Prototype



Crocothemis servilia



Before

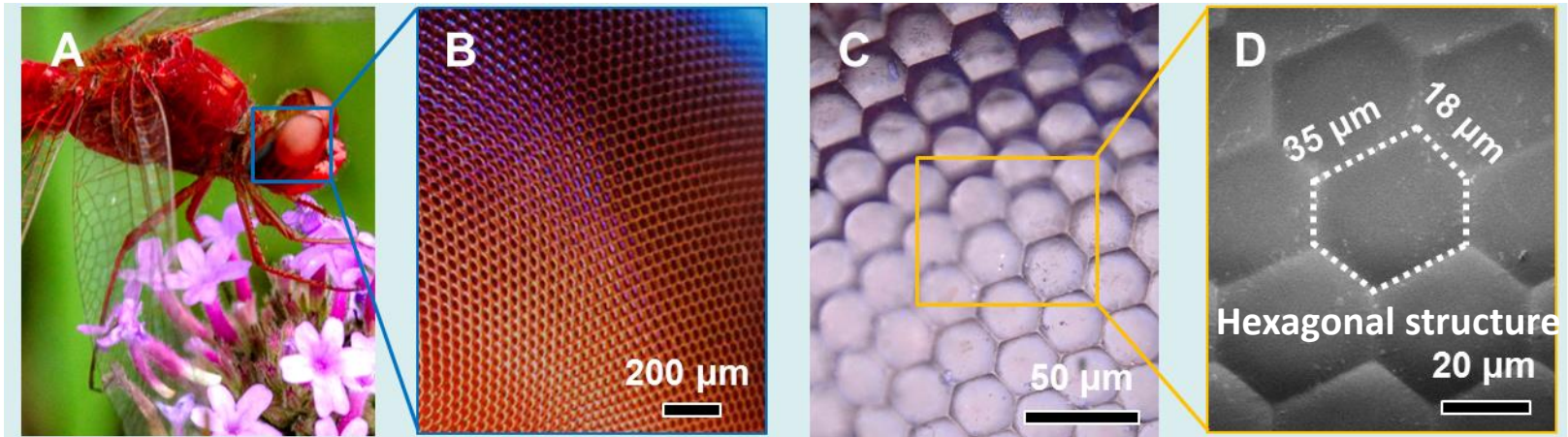
Imitation and reproduction of ommateum surface

Delicate structure inside the ommateum

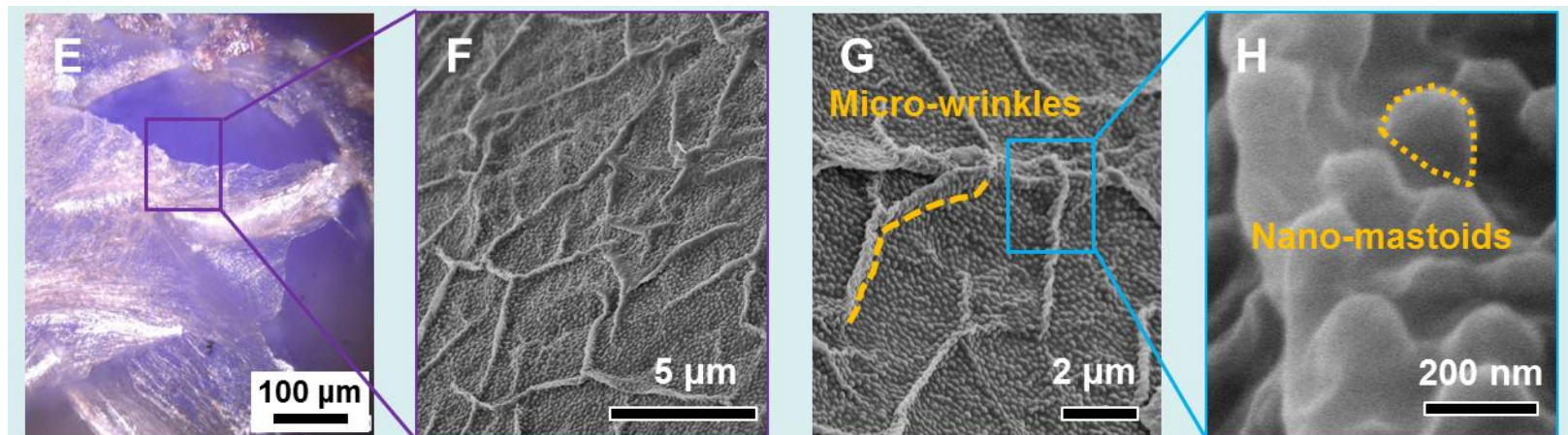
Now

2. Bionic Study

Hexagonal structure on surface

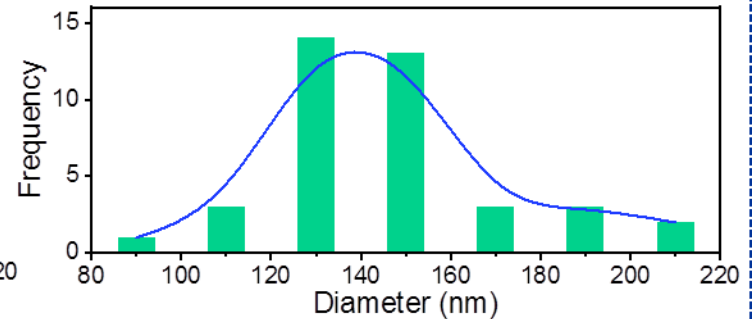
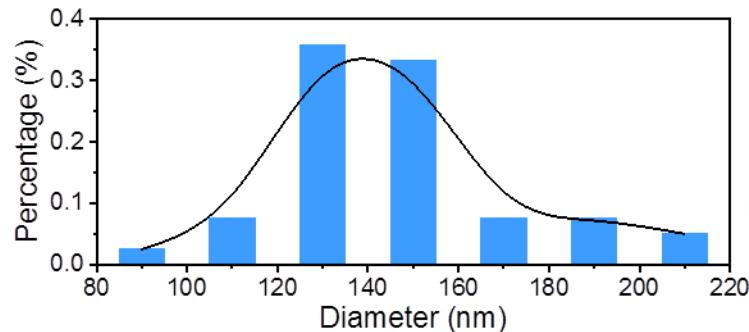
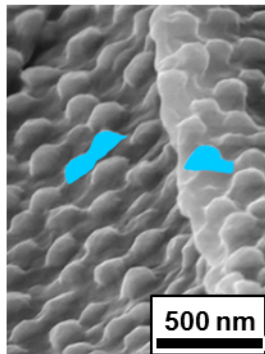


Wrinkle structure on the inner tissue

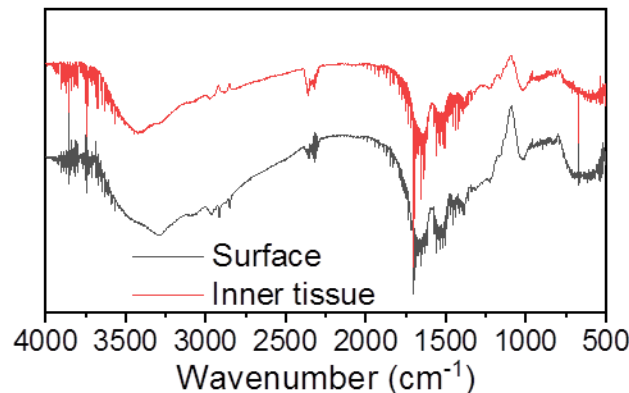
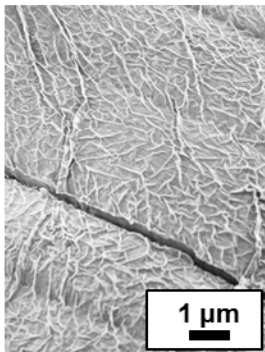


2. Bionic Study

Distribution statistics: Normal distribution, Multi functions



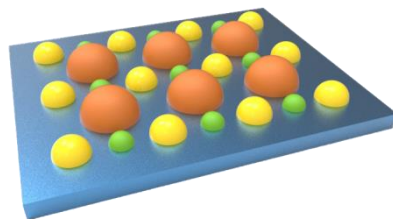
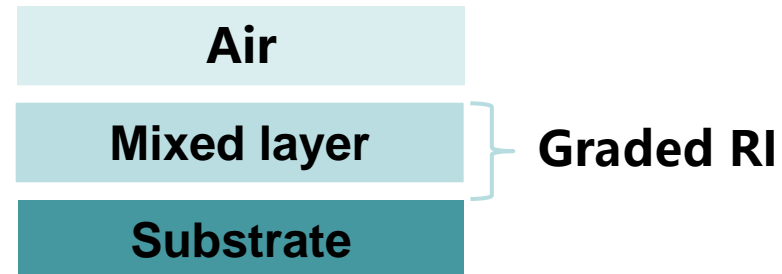
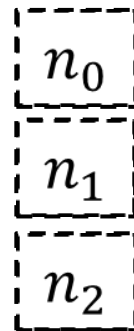
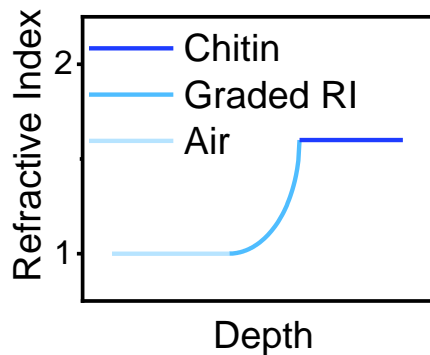
Molecular functional group: same functional group, chitin



- ❖ $667, 2358 \text{ cm}^{-1}$: CO_2 ;
- ❖ $3428, 3260 \text{ cm}^{-1}$: -OH , -N-H ;
- ❖ $2966, 2923, 2874 \text{ cm}^{-1}$: -C-H ;
- ❖ $1655, 1550, 1310 \text{ cm}^{-1}$: -CO-NH_2 , -CO-NH- ;
- ❖ 1076 cm^{-1} : -C-O

2. Bionic Study

Classical Theoretical Formulas



$$r_1 = \frac{n_0 - n_1}{n_0 + n_1}$$

$$r_2 = \frac{n_1 - n_2}{n_1 + n_2}$$

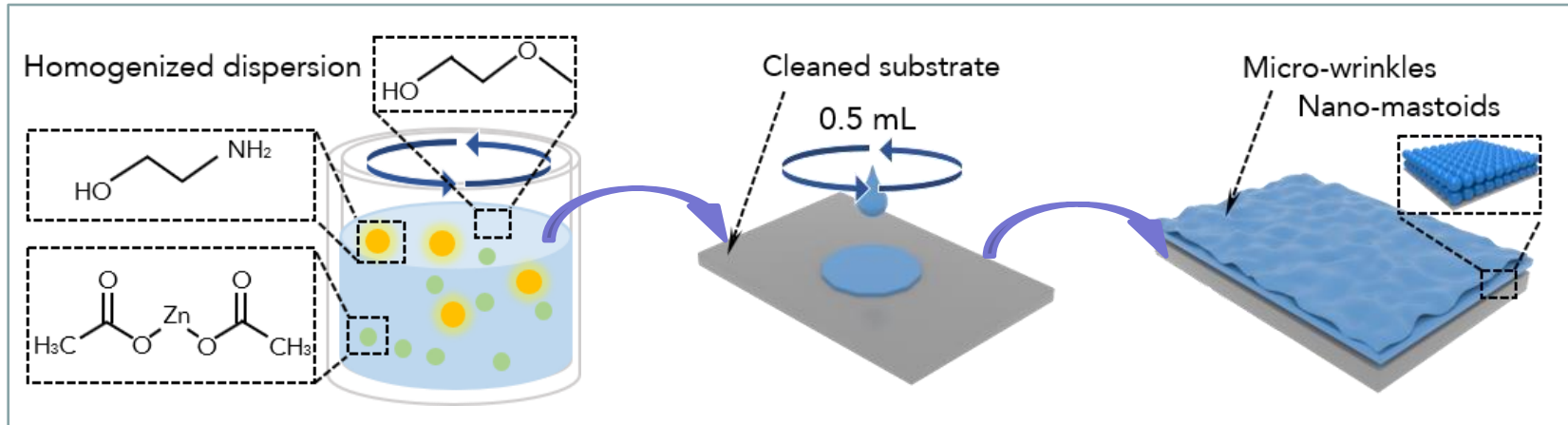
$$R = \left| \frac{E_{or}}{E_{oi}} \right| = \frac{r_2(1 - r_1^2) \sin \varphi}{r_1(1 + r_2^2) + r_2(1 + r_1^2) \cos \varphi}$$

$$R = |r|^2 = \frac{(n_0 m_{11} - m_{22} n_{m+1})^2 + (m_{12} n_0 n_{m+1} - m_{21})^2}{(n_0 m_{11} + m_{22} n_{m+1})^2 + (m_{12} n_0 n_{m+1} + m_{21})^2}$$

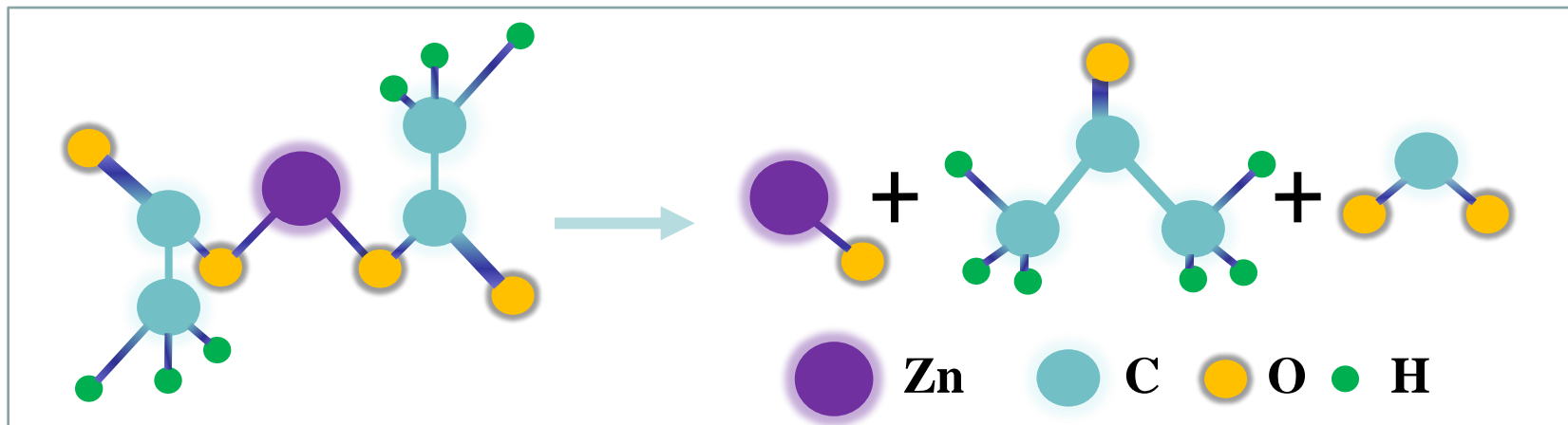
$$\int_{-\infty}^{\infty} \frac{dn}{dZ} \frac{1}{2n} \exp(ikZ) dZ = \varrho(k) \exp[i\phi(k)]$$

3. Design and Processing

Nano-molecule self-assembly

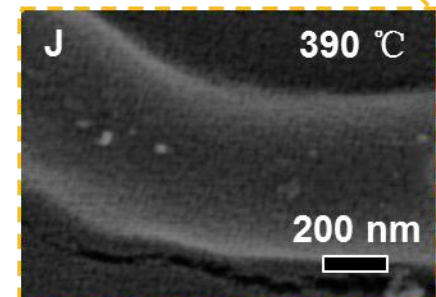
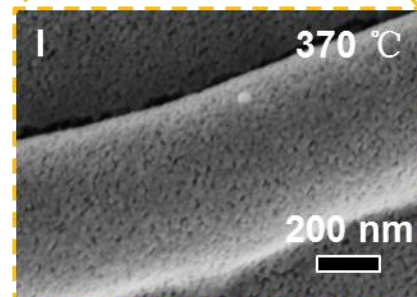
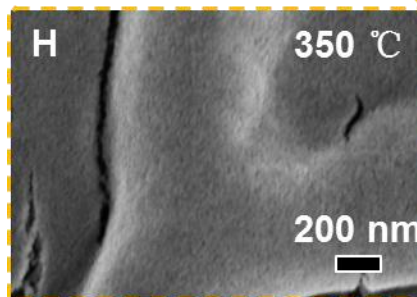
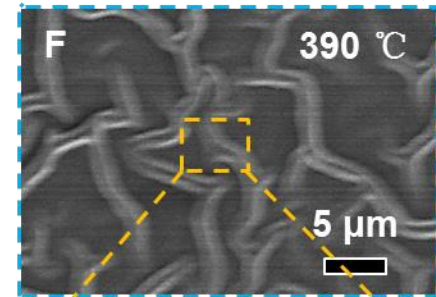
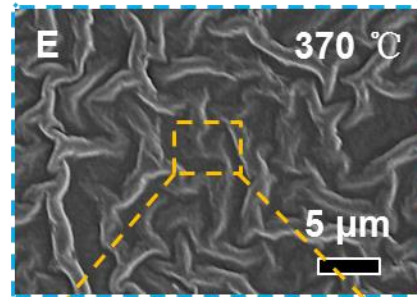
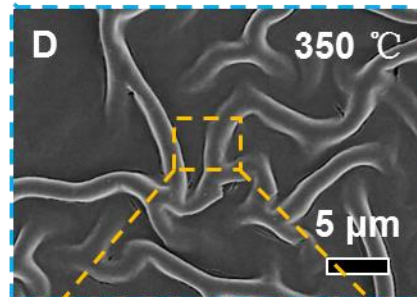
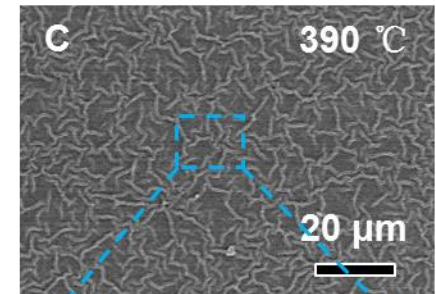
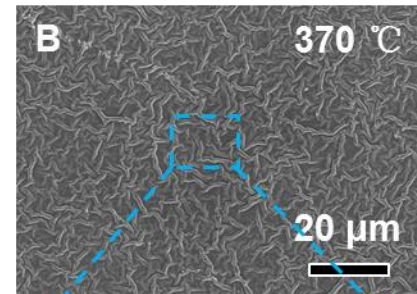
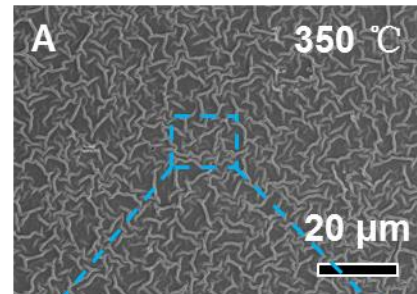


Chemical reaction equation



3. Design and Processing

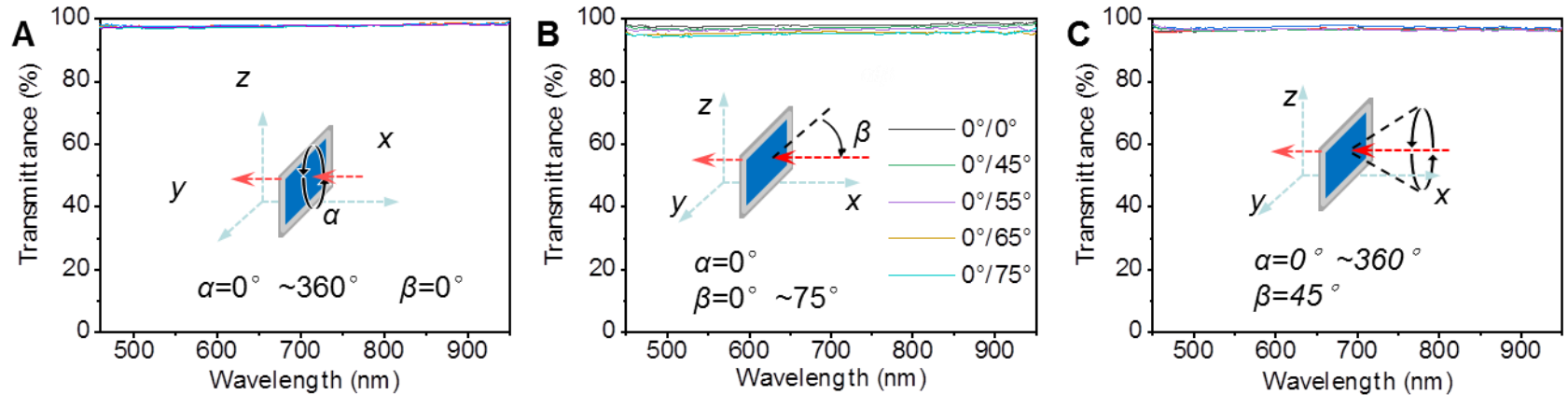
**Micro
component**



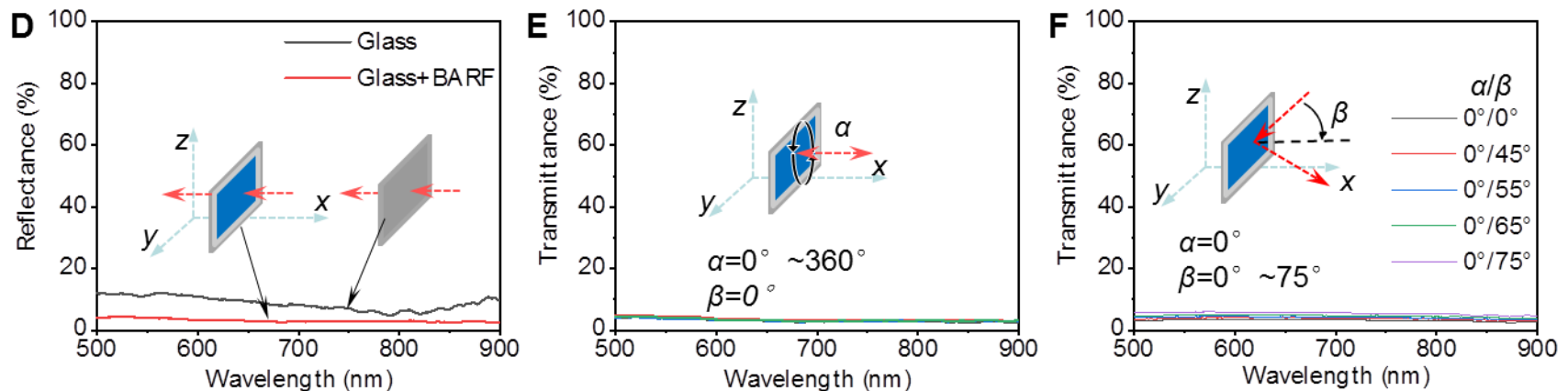
**Nano
component**

4. Achievements and Application

Omnidirectional transmissive property

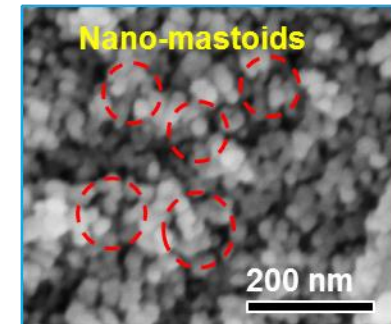
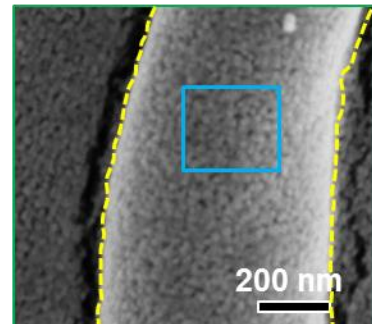
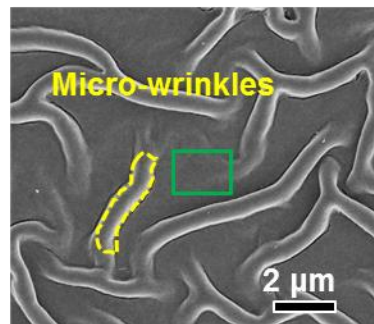
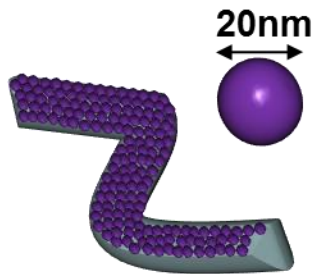
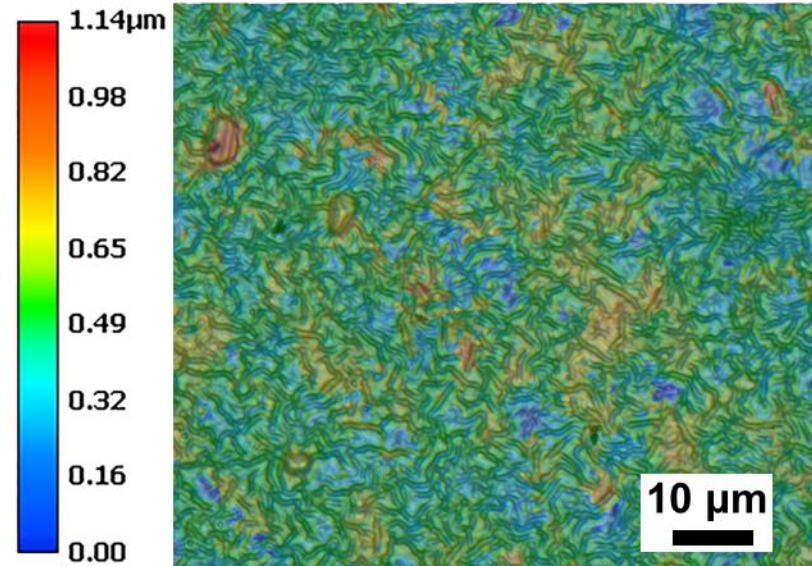
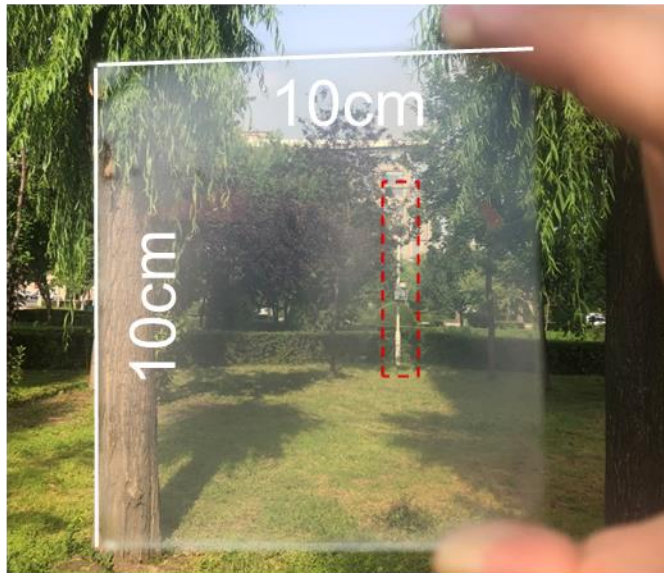


Omnidirectional antireflective property



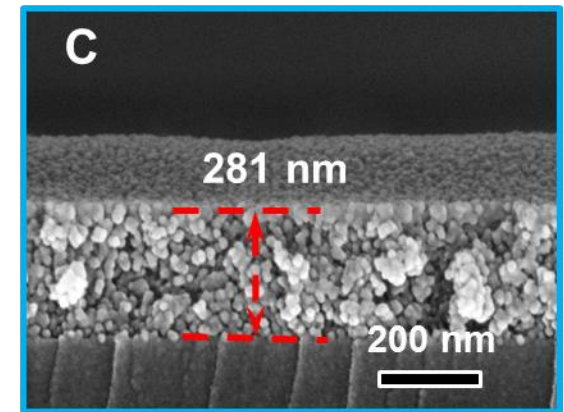
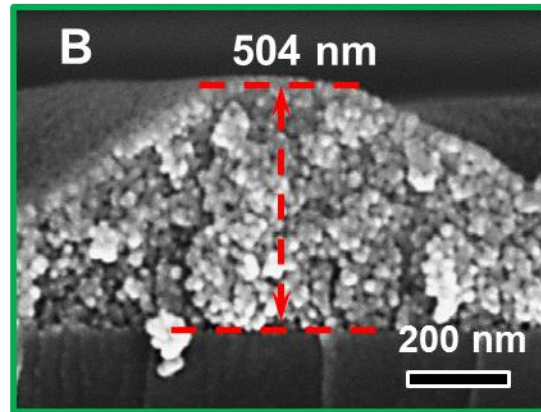
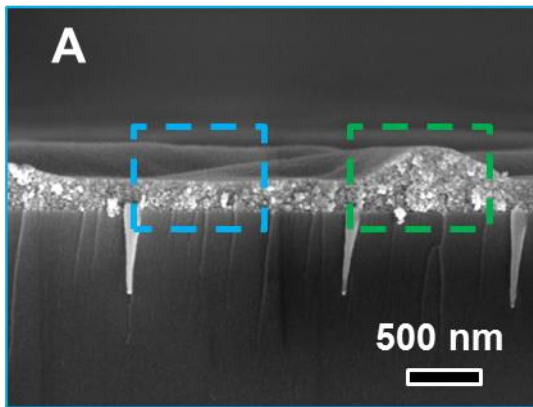
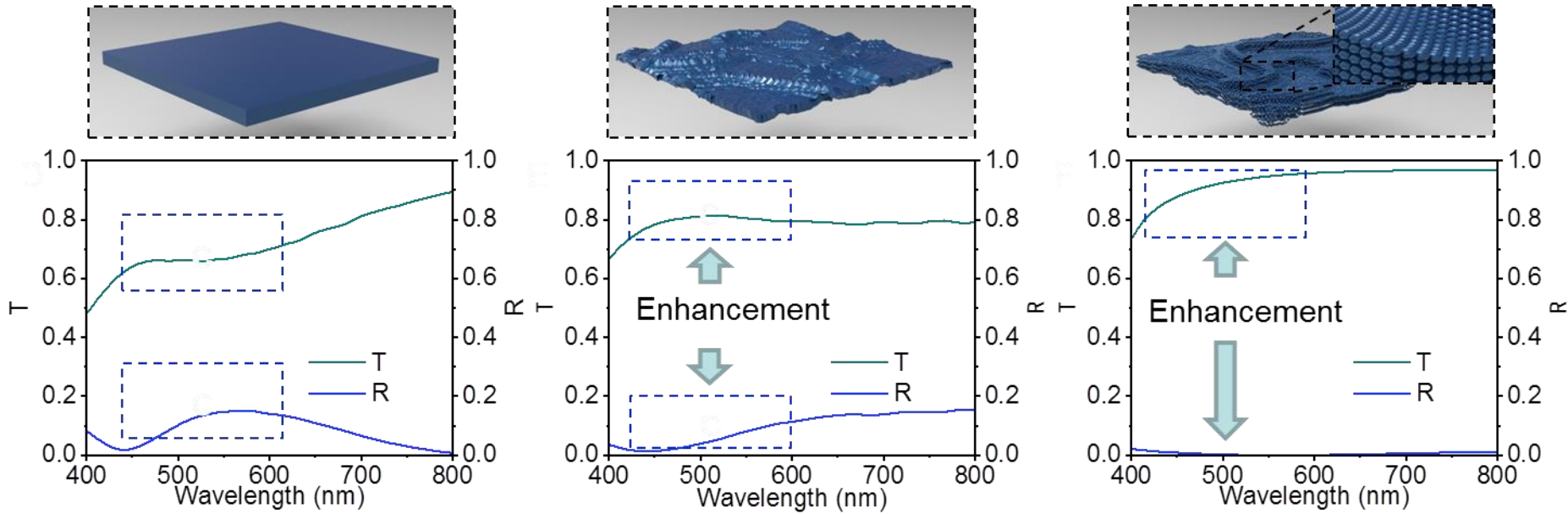
4. Achievements and Application

BARF on large scale glass slide



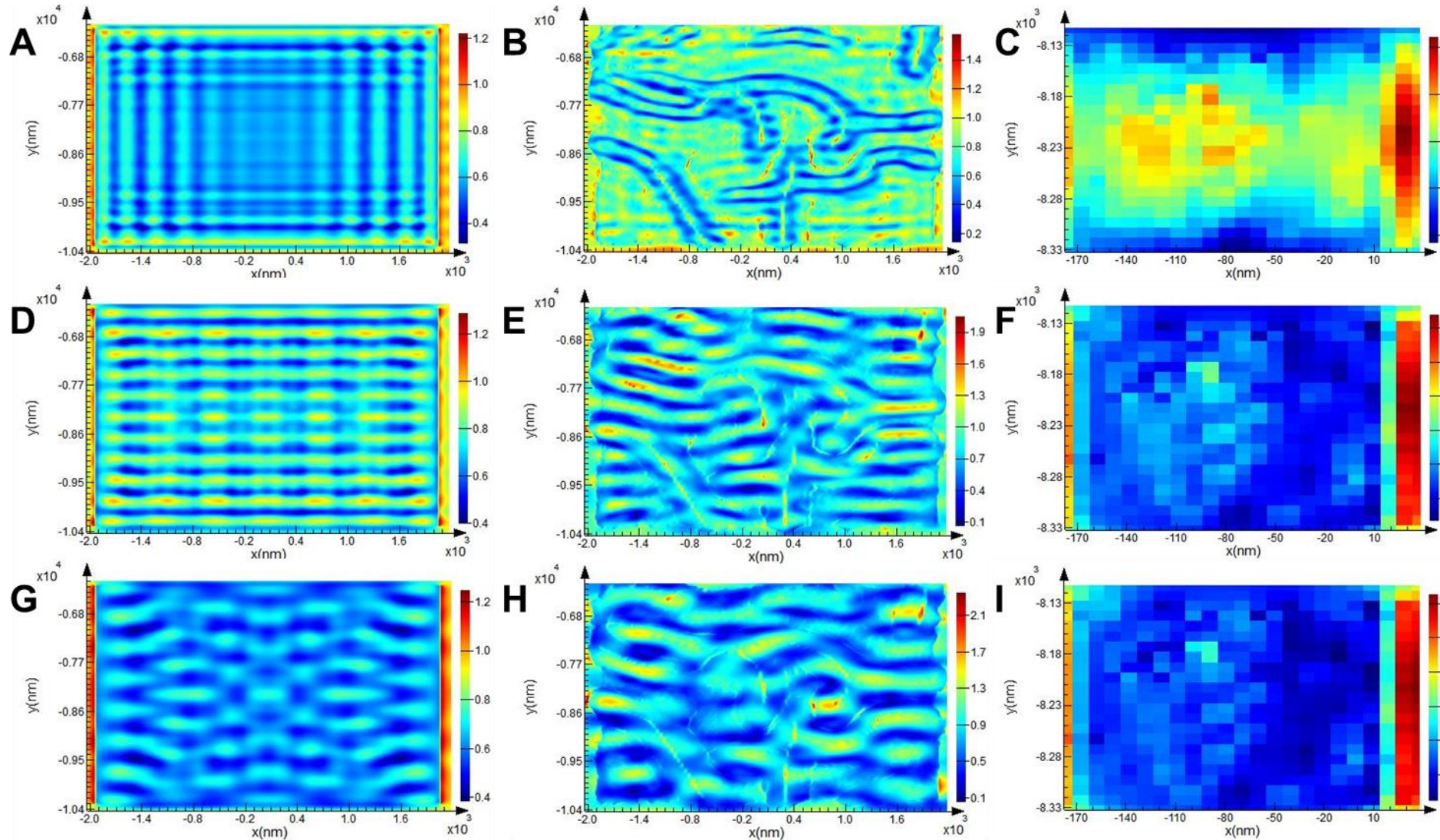
4. Achievements and Application

Structural simulation analysis



4. Achievements and Application

Energy distribution



4. Achievements and Application

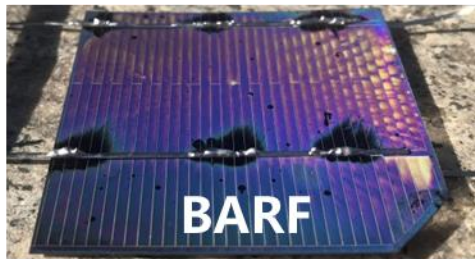
BARF on silicon based solar panels

Original AR structure

AR structure with BARF



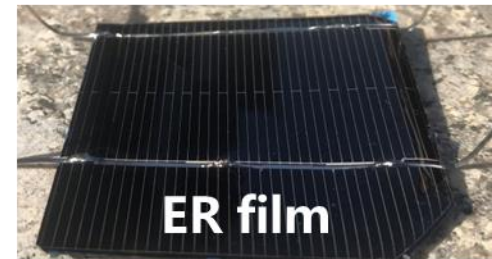
A



B



C



D



E

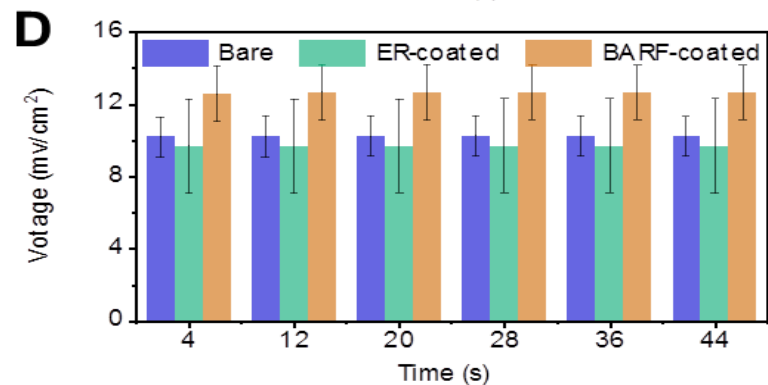
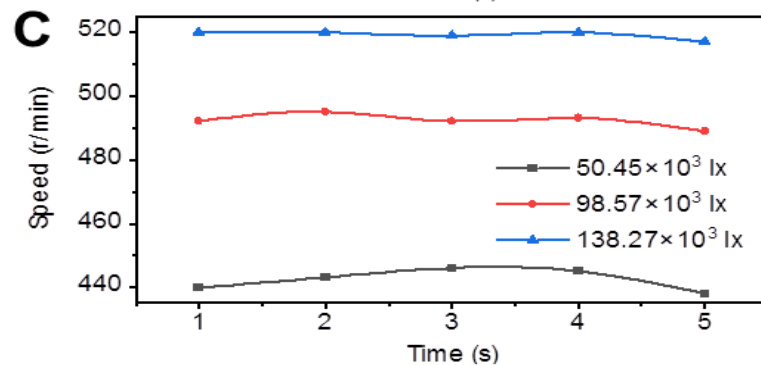
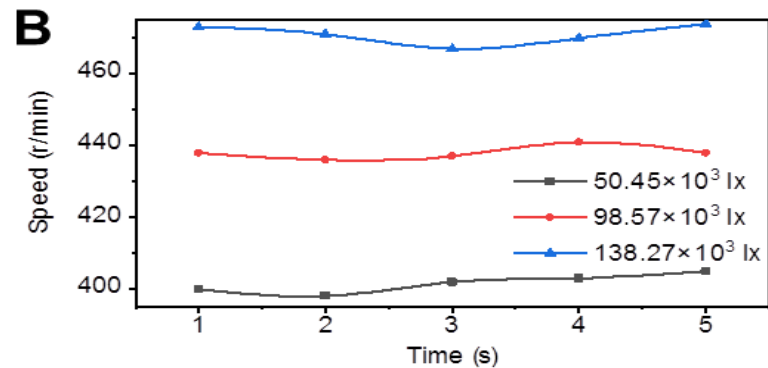
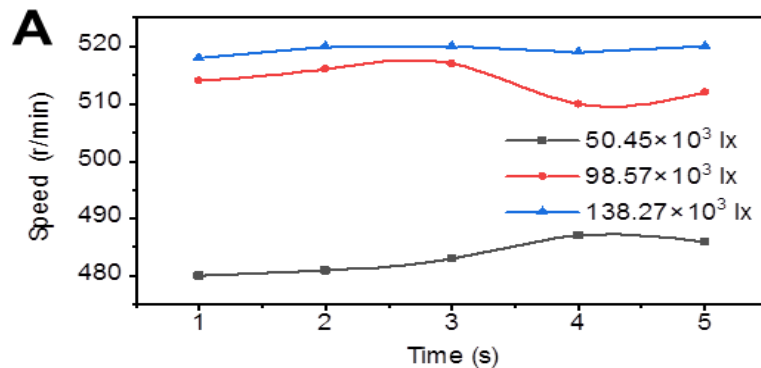
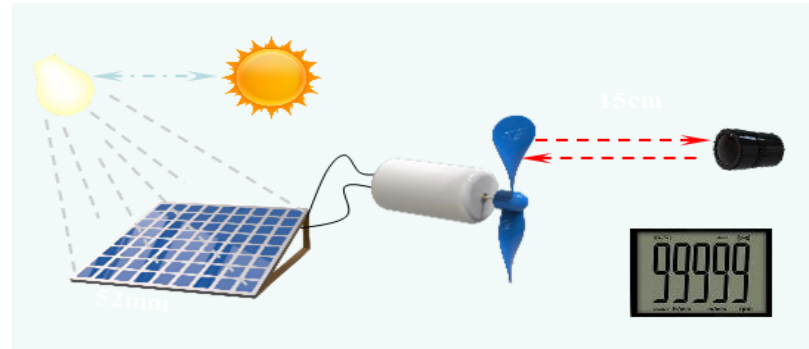


F



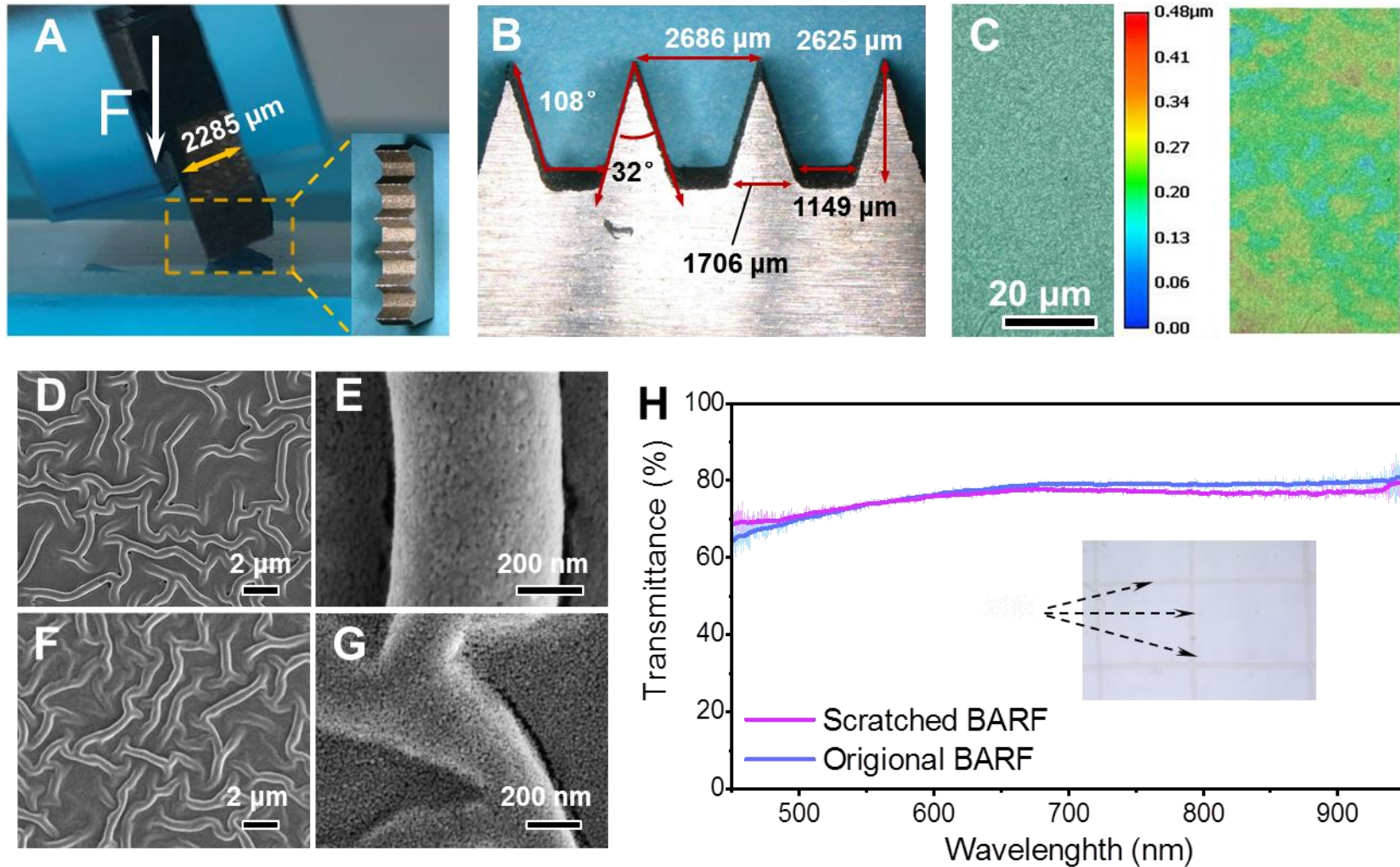
4. Achievements and Application

Output performance of solar panels



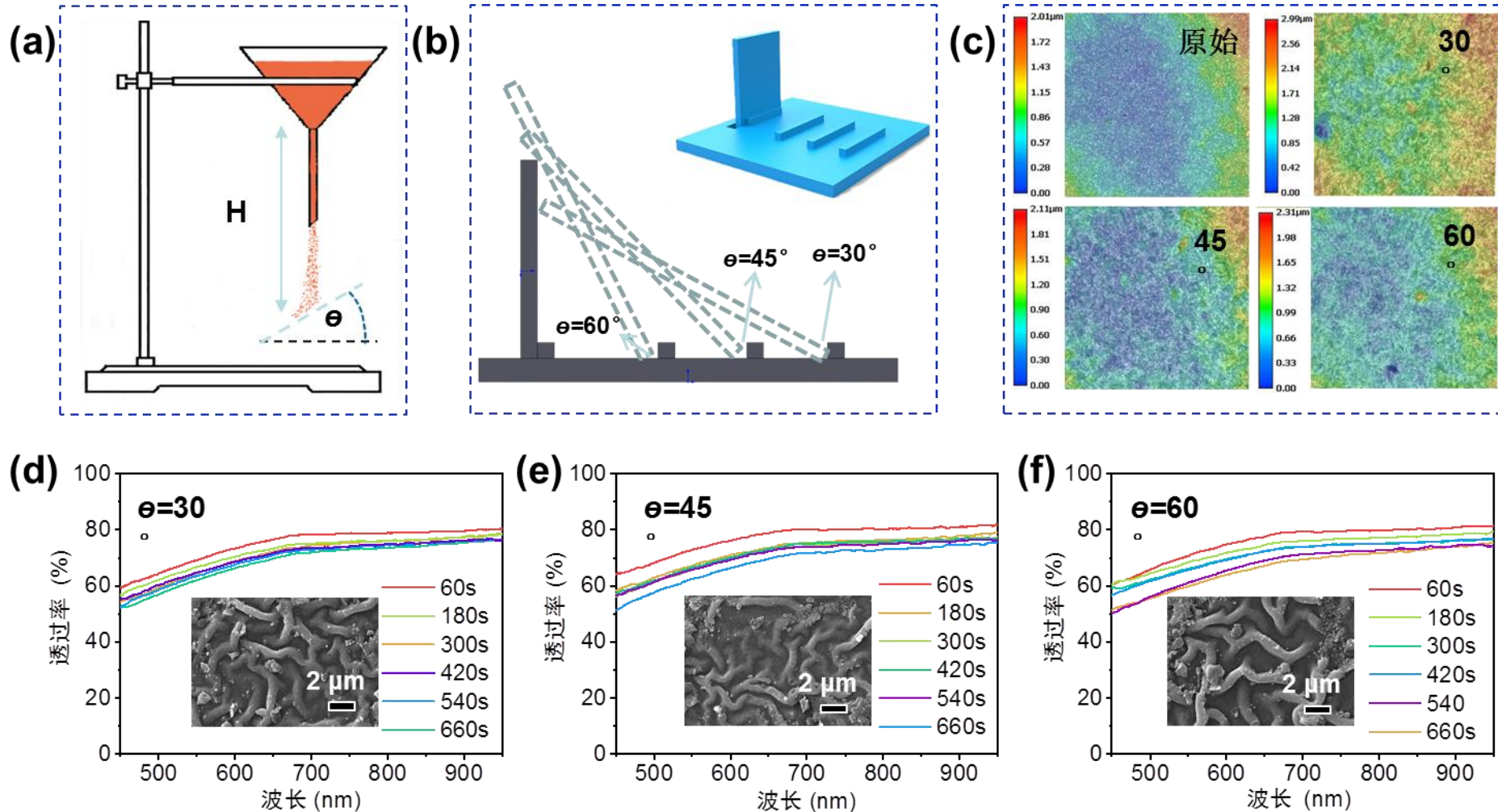
4. Achievements and Application

Scratching test of BARF



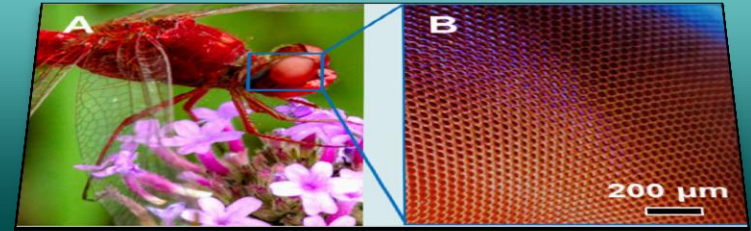
4. Achievements and Application

Sand-falling test of BARF

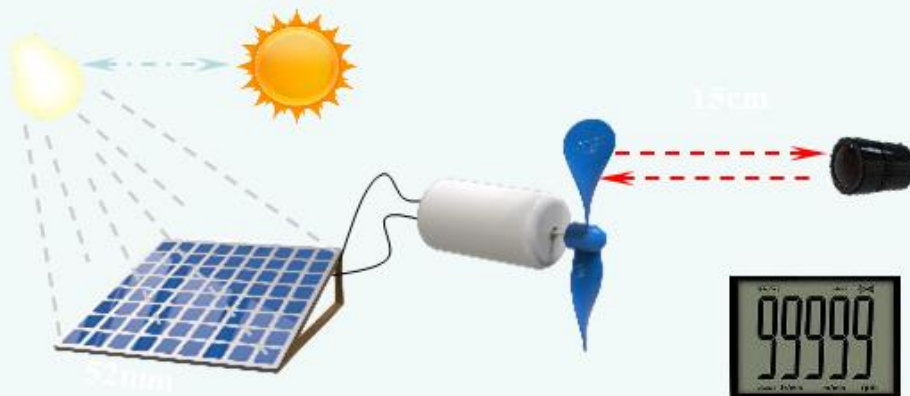




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***The bioinspired antireflective
technique has been applied in solar
energy collection.***



The case was provided by the
Individual Member of ISBE
(Shichao Niu, Jilin University)