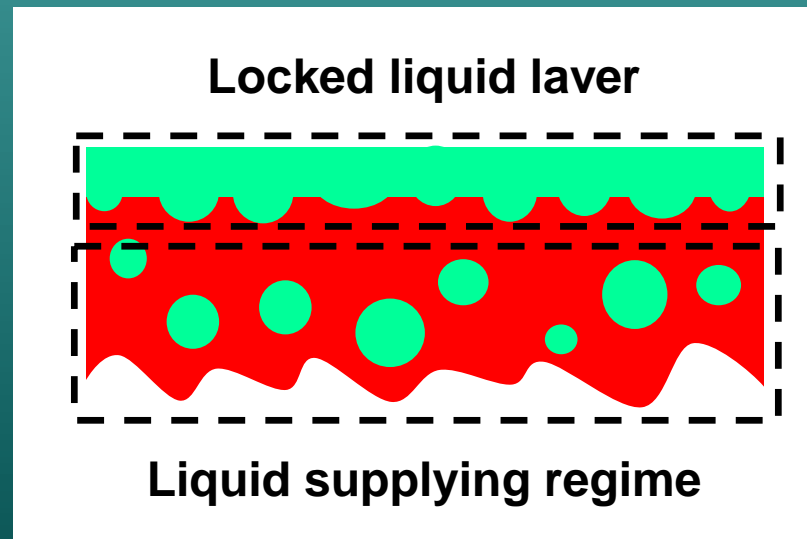




INTERNATIONAL SOCIETY OF  
BIONIC ENGINEERING

# Earthworm-inspired anti-fouling coatings

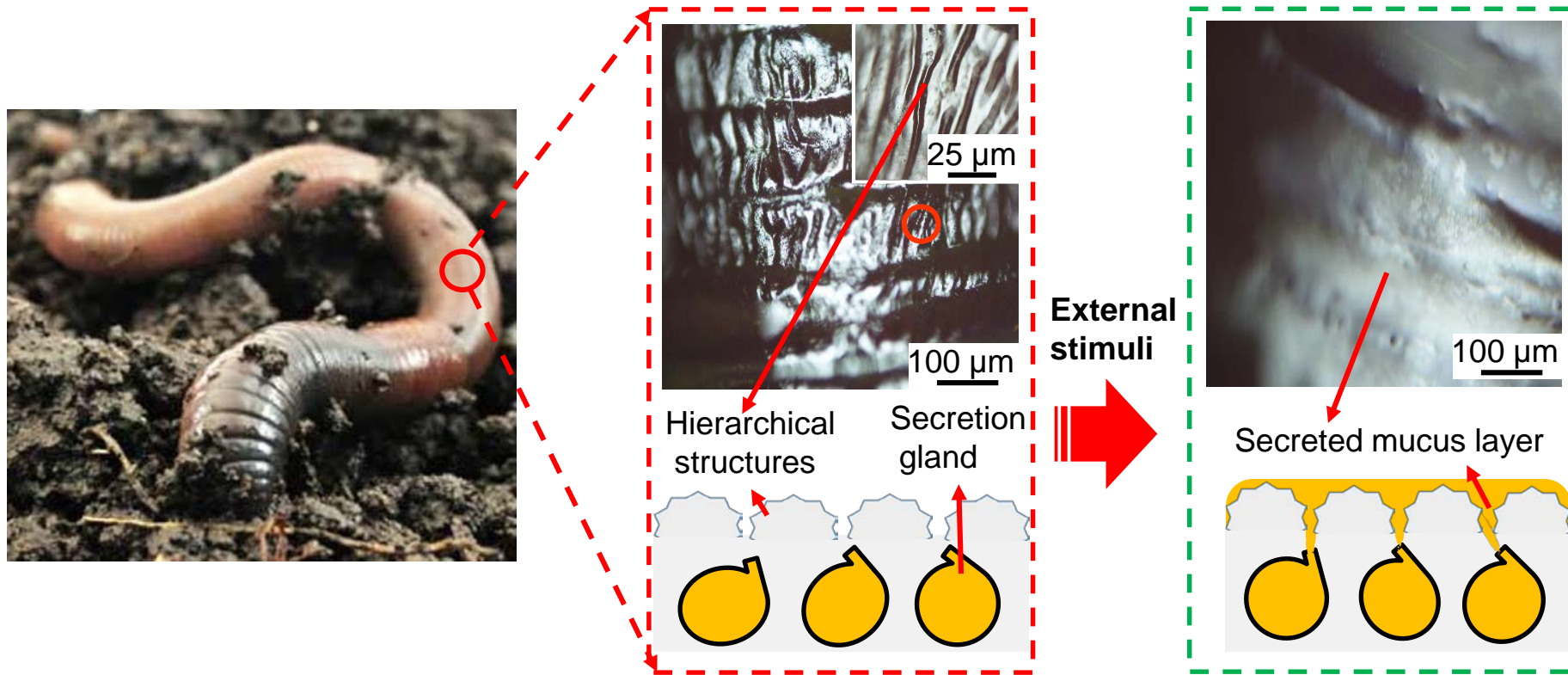
*Droplet-embedded secretion materials*



The case was provided by the Individual Member of ISBE (Jiaxi Cui)

# 1. Biological Prototype and Bionic Study

Biological model: earthworms with **unique self-lubricating mechanism** can pass through adhesive soil (a solid environment) without inducing stains.

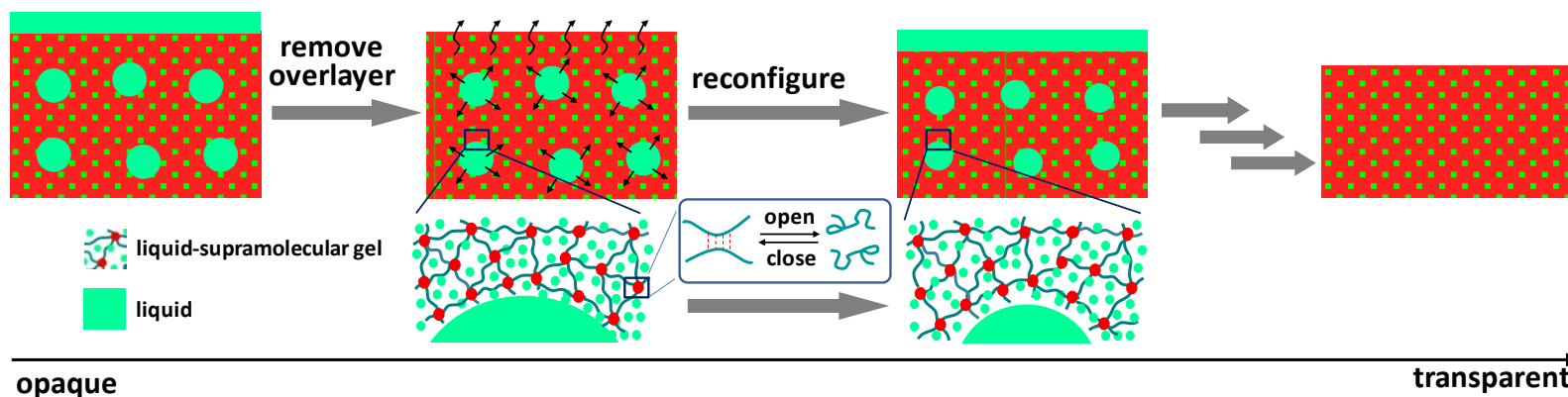


- The sophisticated epidermal glands can continually secrete mucus under external mechanical stimuli
- Rough skin consisting of macroscopic annuli and microripples can stabilize the secreted mucus to form a thick slippery layer.

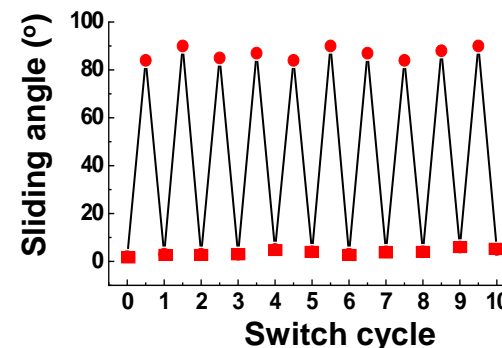
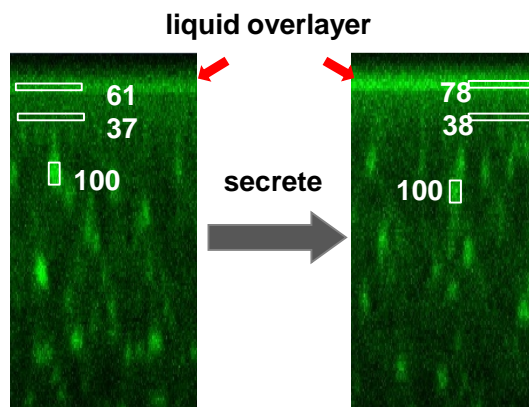
# 2. Design and Processing

**Self-regulated secretion** of *droplet-embedded supramolecular gels*: the lubricant is stored in droplets, which would be released from the droplets when the lubricant on the surfaces is consumed to expose the surface of matrices, to restore the oil-covered slippery structure.

$$S = \gamma_{ga} - (\gamma_{la} + \gamma_{gl}) > 0$$

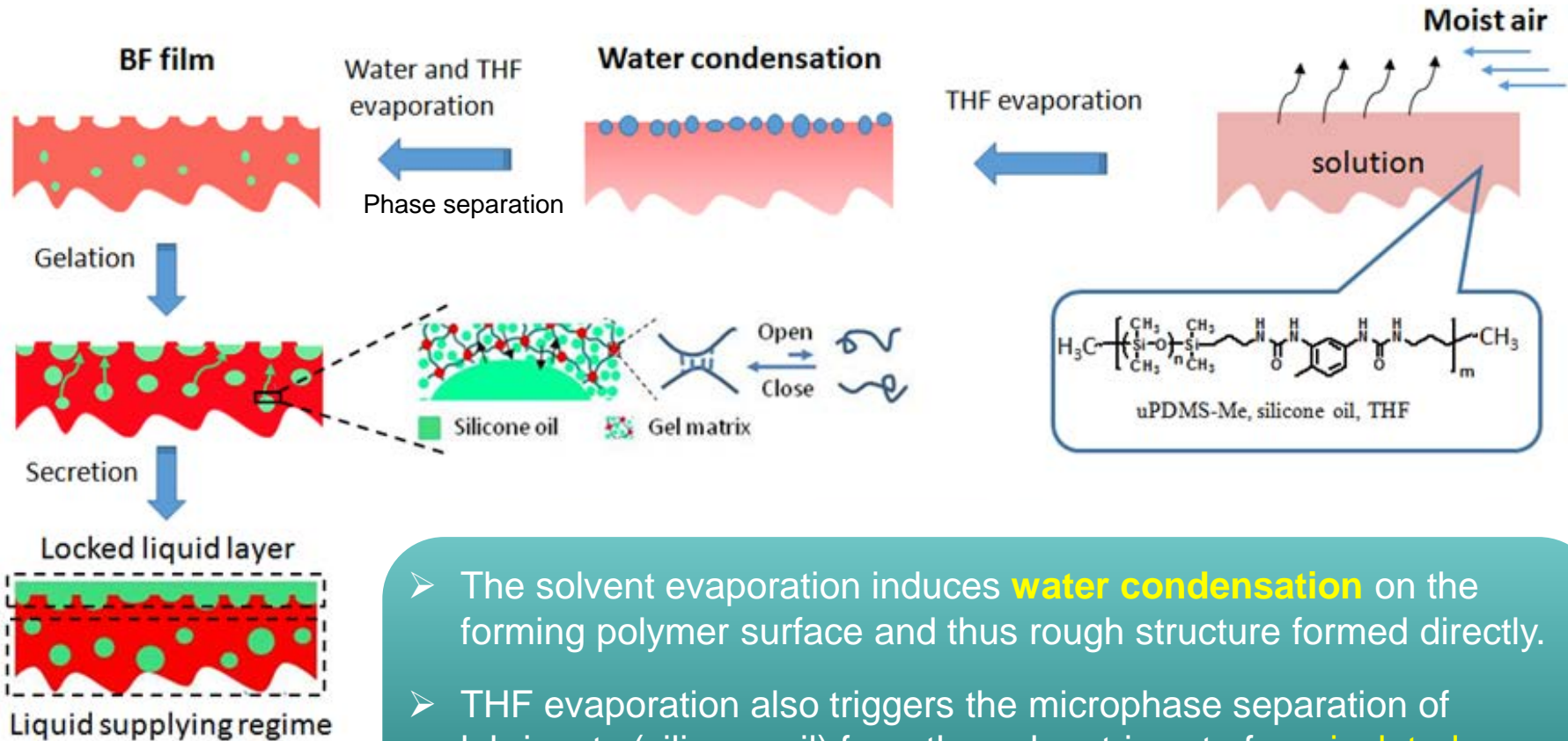


- Removing the liquid overlayer triggers secretion of the stored liquid to the exposed surface
- Liquid-covered surface is slippery



# 2. Design and Processing

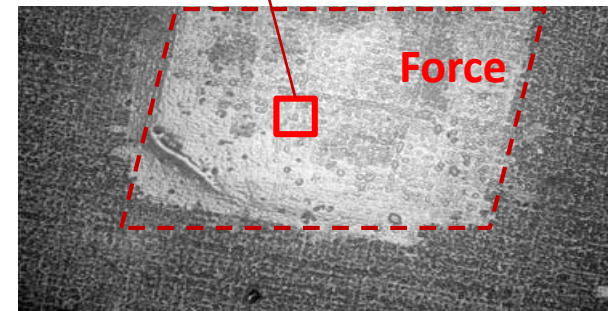
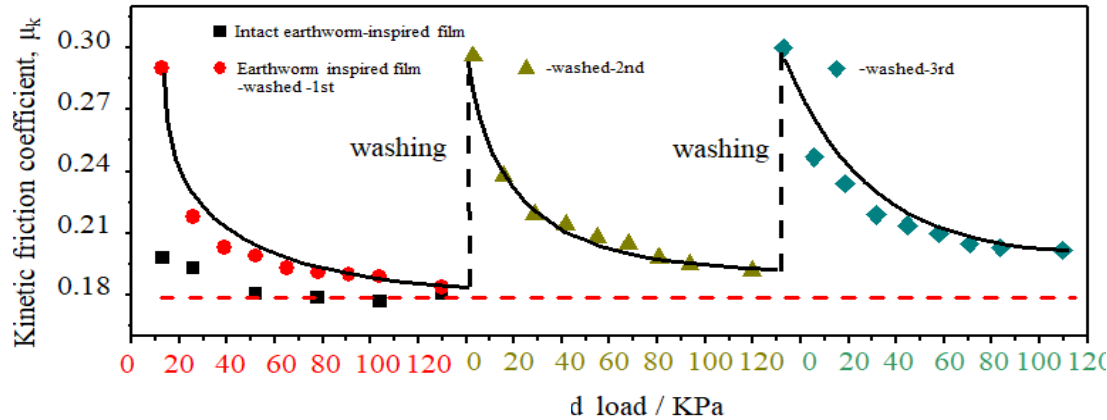
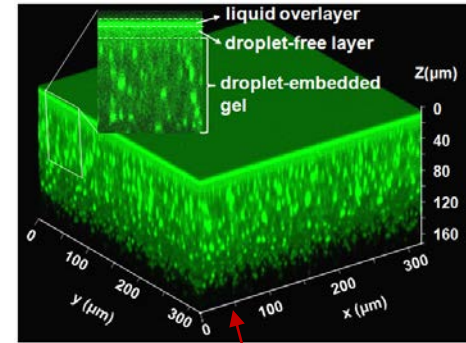
Construction of earthworm-inspired coatings by using secretion materials:



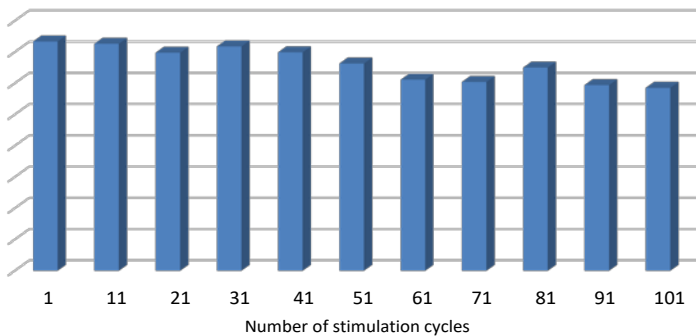
- The solvent evaporation induces **water condensation** on the forming polymer surface and thus rough structure formed directly.
- THF evaporation also triggers the microphase separation of lubricants (silicone oil) from the gel matrices to form **isolated droplets within the gel**.
- The supramolecular gel matrices can **reconfigure** through **reversible bond disassembly** and reassembly to adapt quickly to the external stimulus.

# 2. Design and Processing

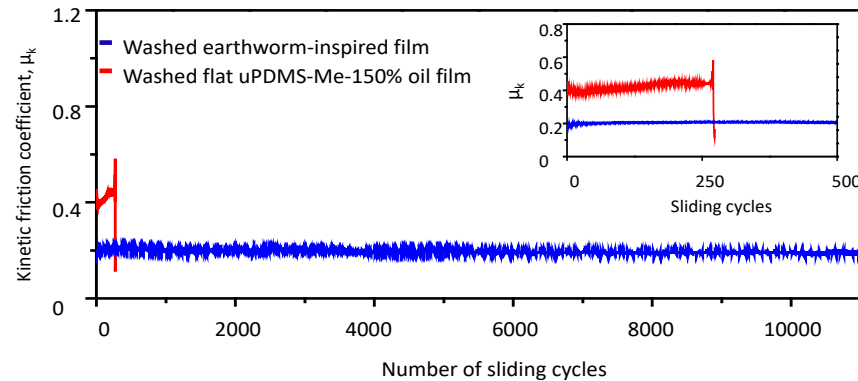
- A structure with droplet-embedded bulk matrix and oil-covered textured surface self-forms;
- Multi-time release of entrapped lubricant;
- Entrapped lubricant is released in less than 1 sec;



## ★ Long-term drag reduction



## ★ Wear stability



# 3. Achievements and Application

## ■ Property

- **Anti-fouling**
- Drag-reduction
- Patterned coating
- Mechano-responsive
- Self-healing
- Thermo-responsive
- Solvent-responsive
- Droplets self-born



## ■ Application in fields



Outdoor monitoring



Fishery



Marine antifouling



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*The self-lubricating technique (current bionic technique) has been applied in anti-fouling.*