Self-adaptive gripper based on liquid crystal elastomer

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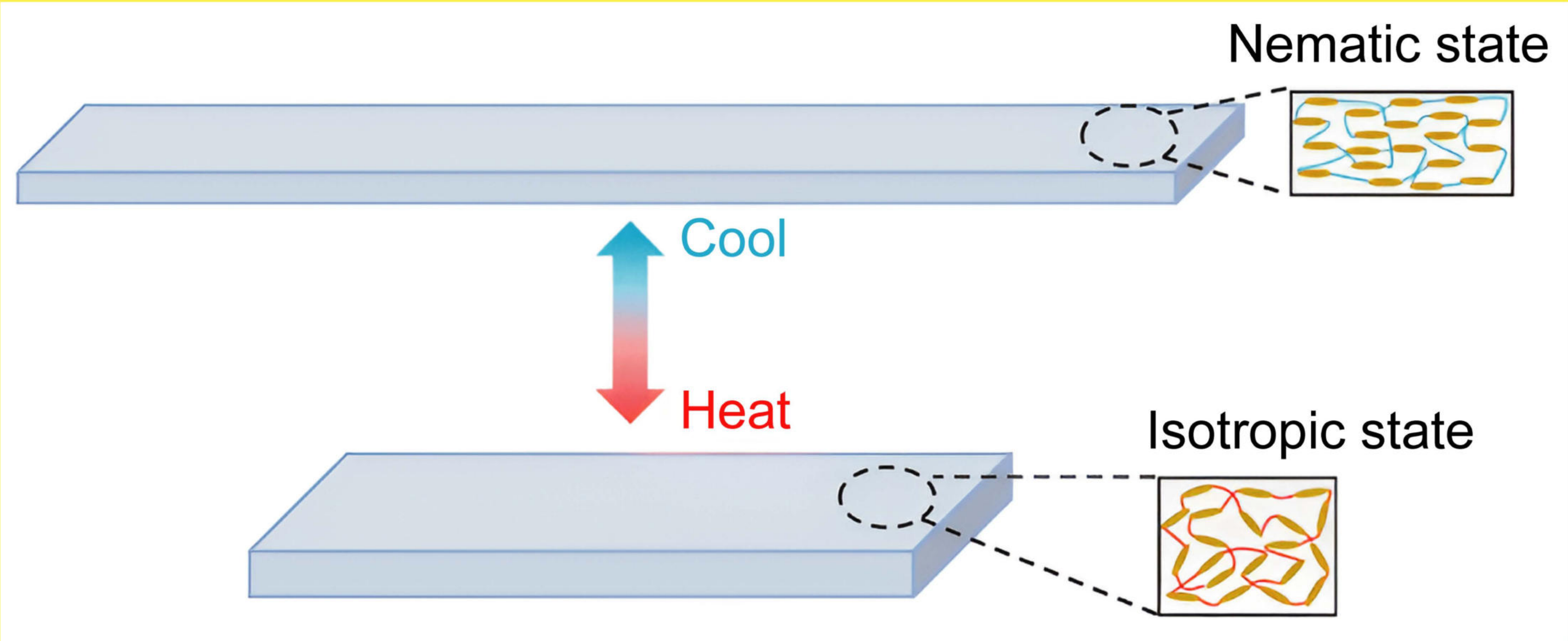
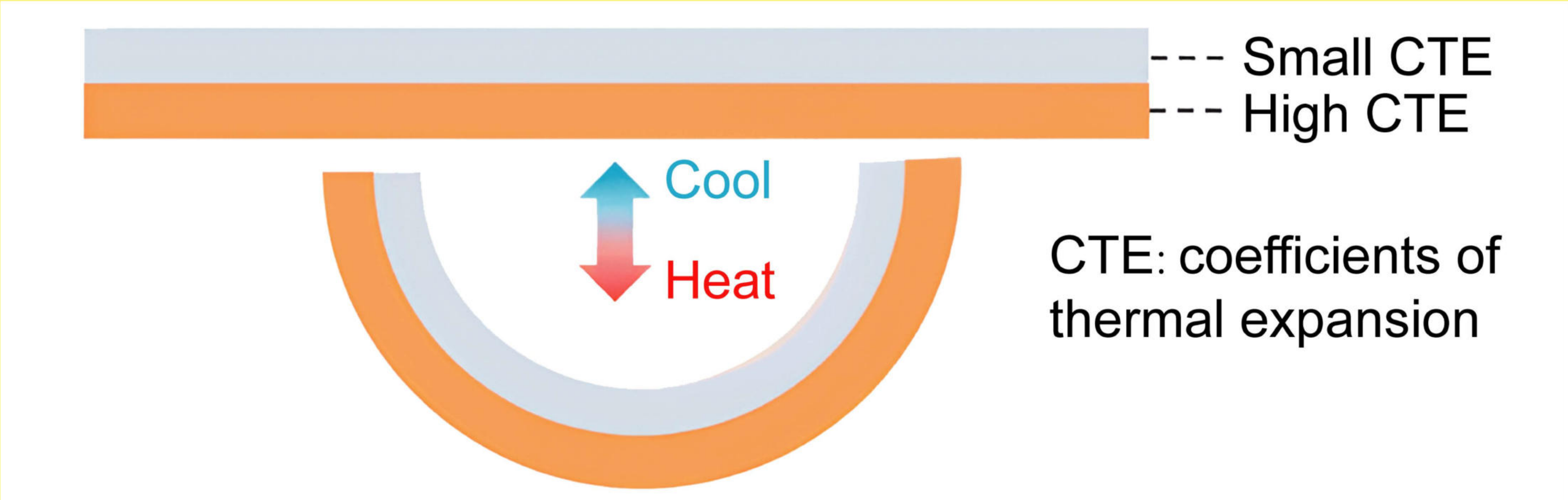
Background

- Traditional systems are not robust in some extreme situations
- Physical intelligence: materials respond to external stimulus

- Liquid crystal elastomer can shrink when heated



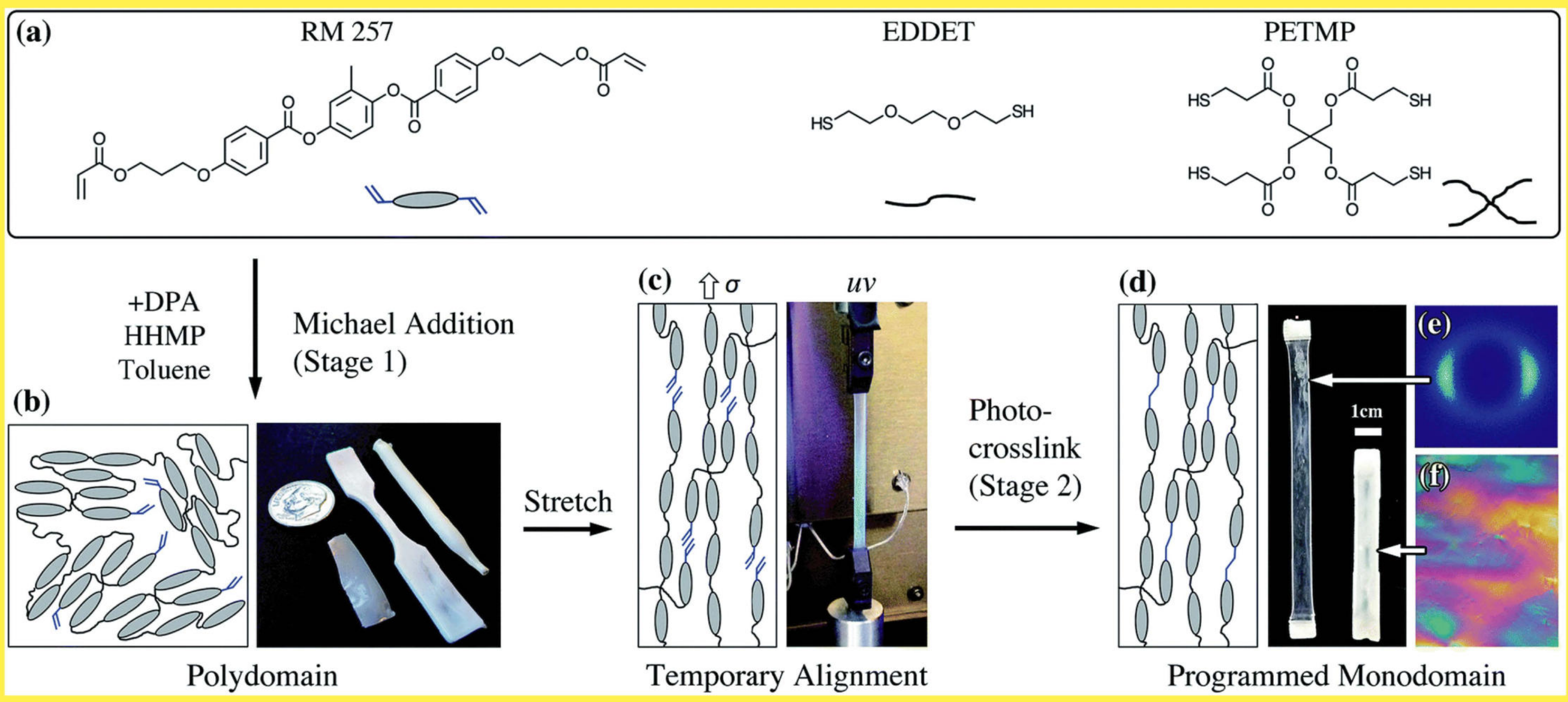
- Two-layer structure with different CTEs bend under heat



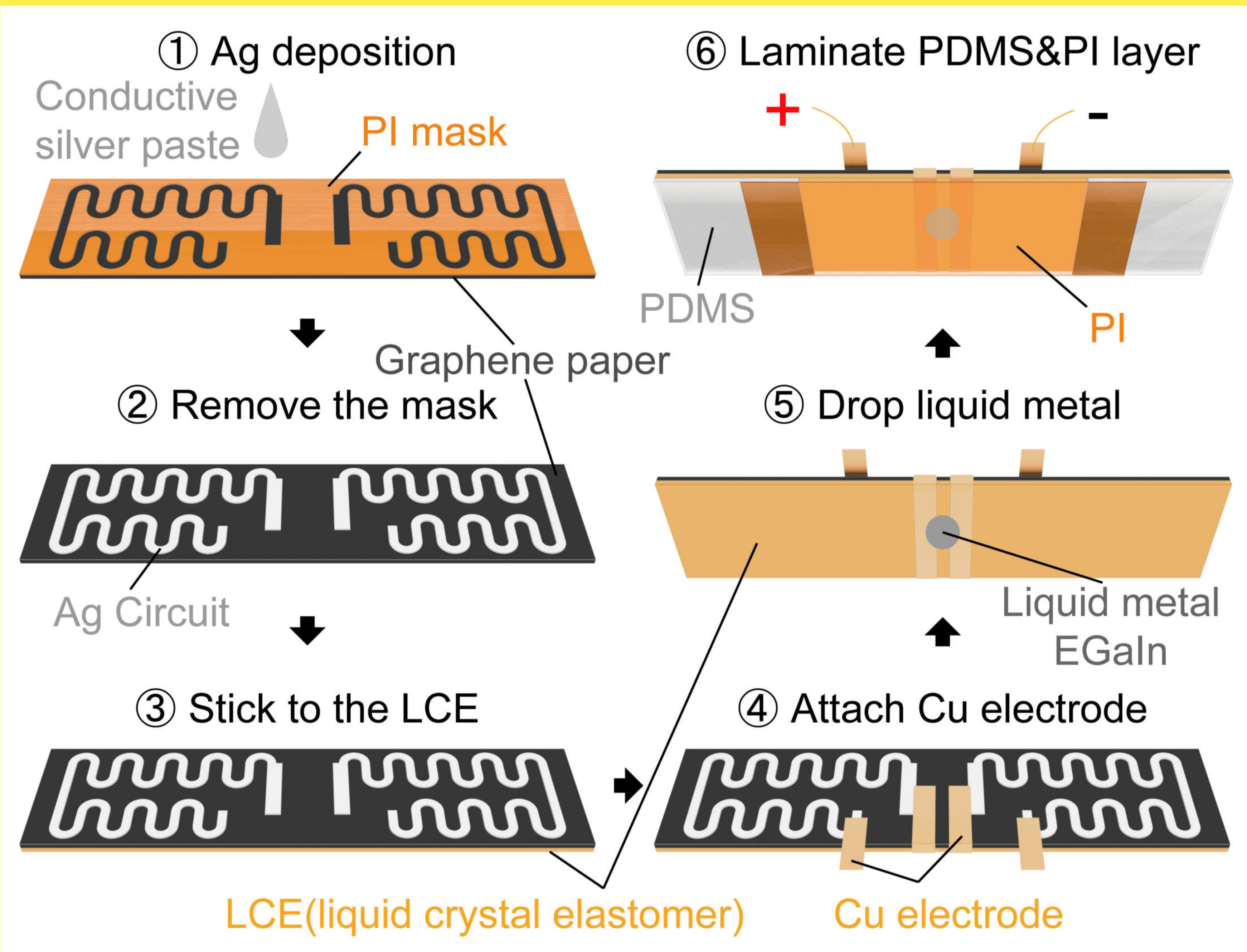
How to make a self-adaptive gripper based on this structure?

Fabrication

- The synthesis of liquid crystal elastomer

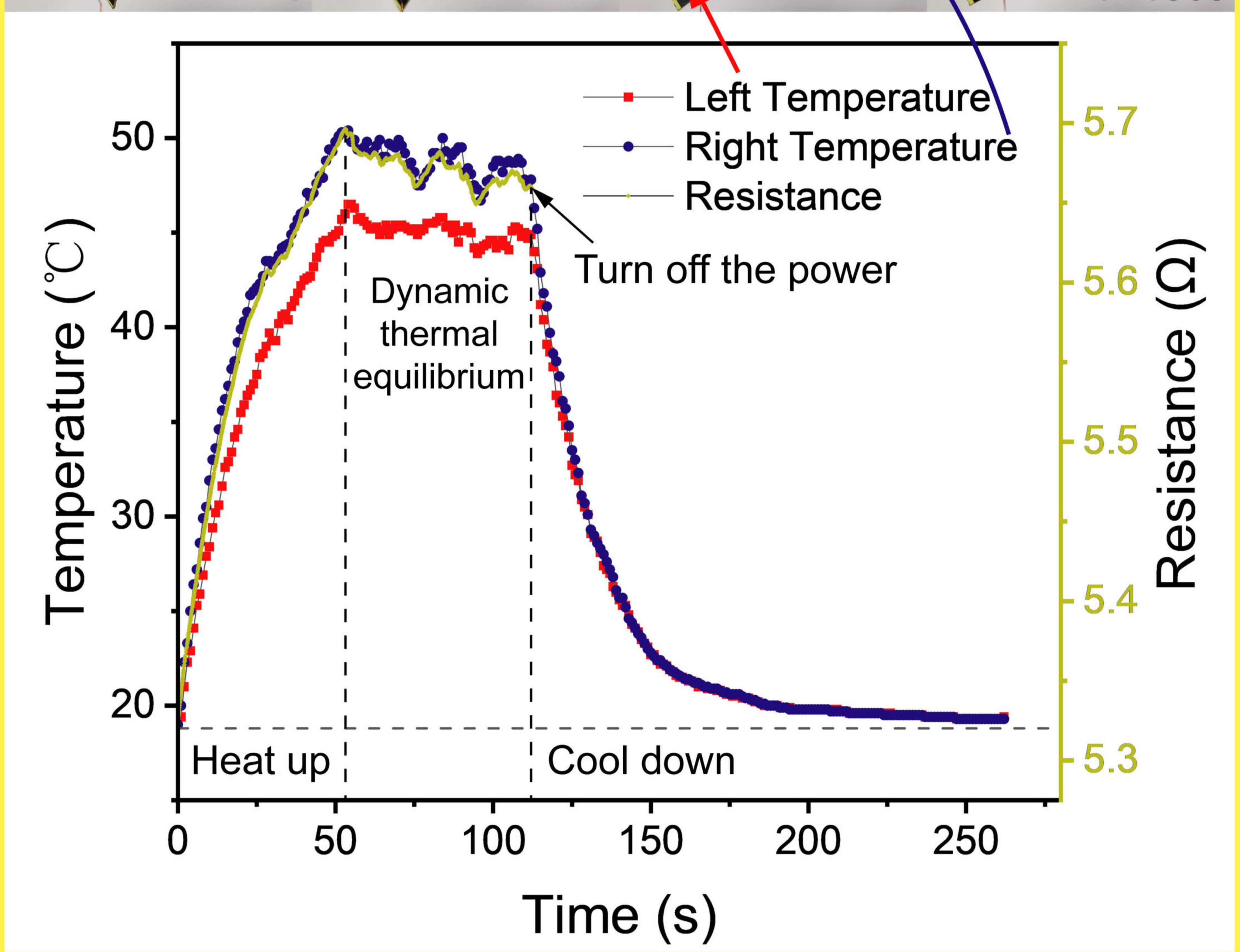


- The fabrication of self-adaptive gripper



Characterization

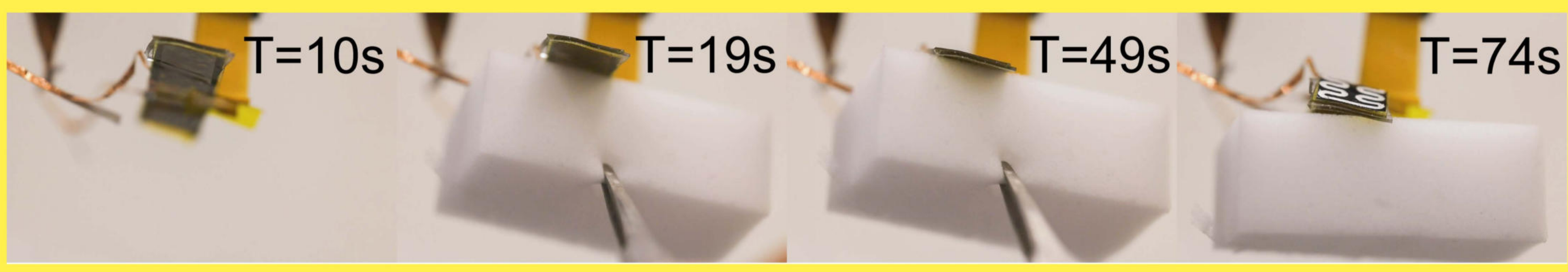
- A constant current source was connected across the circuit.
- After maintaining a stable bending condition for a period, the power supply was turned off to allow natural cooling of the circuit.
- Thermocouples were used to measure the temperatures on the left and right sides of the circuit independently.
- The circuit resistance was calculated using the real time voltage recorded by the constant current source.



- Due to the resistance difference between the left and right circuit paths, a temperature disparity was observed between the two sides.
- The trend of resistance change closely matched the temperature variation trend, which aligned with theoretical expectations.

Demonstration

- When the object made contact with the underlying PI layer, the liquid metal was displaced upward to close the circuit, activating the gripper to capture the object.



Conclusion

- This work developed a self-adaptive gripper capable of autonomous object grasping upon physical contact, demonstrating that material systems can exhibit physical intelligence without relying on electronic chips. The touch-responsive mechanism, enabled by smart material design, achieves intelligent grasping behavior through inherent material properties rather than conventional computational control.

Future work

- Optimize geometric parameters to amplify gripping forces through computational modeling and experimental validation.
- Introducing shape memory polymers to reduce energy consumption during object retention while maintaining grasp stability.