Responsive Interference Coloration Sensors (OTT1610)

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RIC Problems

Problems with color interference technology:

- Current methods requires a lot of productions steps
- Current processes make mass production costly

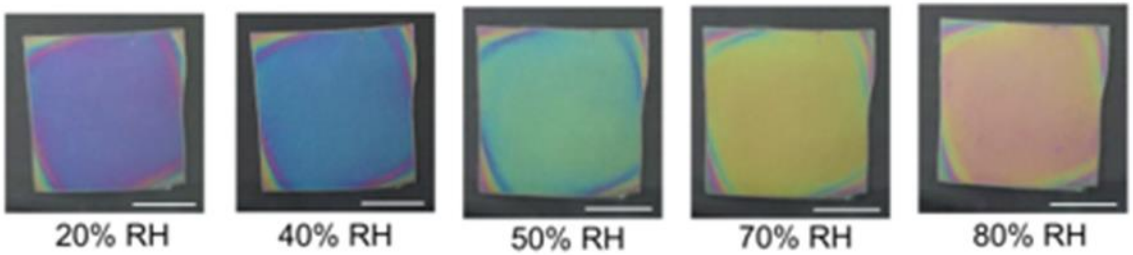
Limitations of competitors:

- Rigid films (not stretchable)
- Lack organic-based materials
- Subject to environmental degradation
- Electronic based humidity sensors are expensive and require power
- Paper-based humidity sensors use cobalt chloride which is cheap and does not require power, but is toxic, non-real-time sensing and has a limited reliability and shelf life.

RIC Solutions

Further, new class of smart polymers can sense their environment (e.g. humidity, temperature, chemicals, biomolecules, light, or mechanical forces), and change the shape, volume, or thickness accordingly. Compared with most interference coloration sensors, this layered polymer-based material has many advantages:

- Lower cost
- Zero power consumption
- Flexible material
- Good processability



- Obtain color that will not degrade in the environment! Impervious to UV light, heat, moisture and oxygen degradation.
- Excellent corrosion resistance
- Light-weight
- Fast, dynamic and reversible response
- Spatial and temporal resolution

Intellectual Property and Licensing

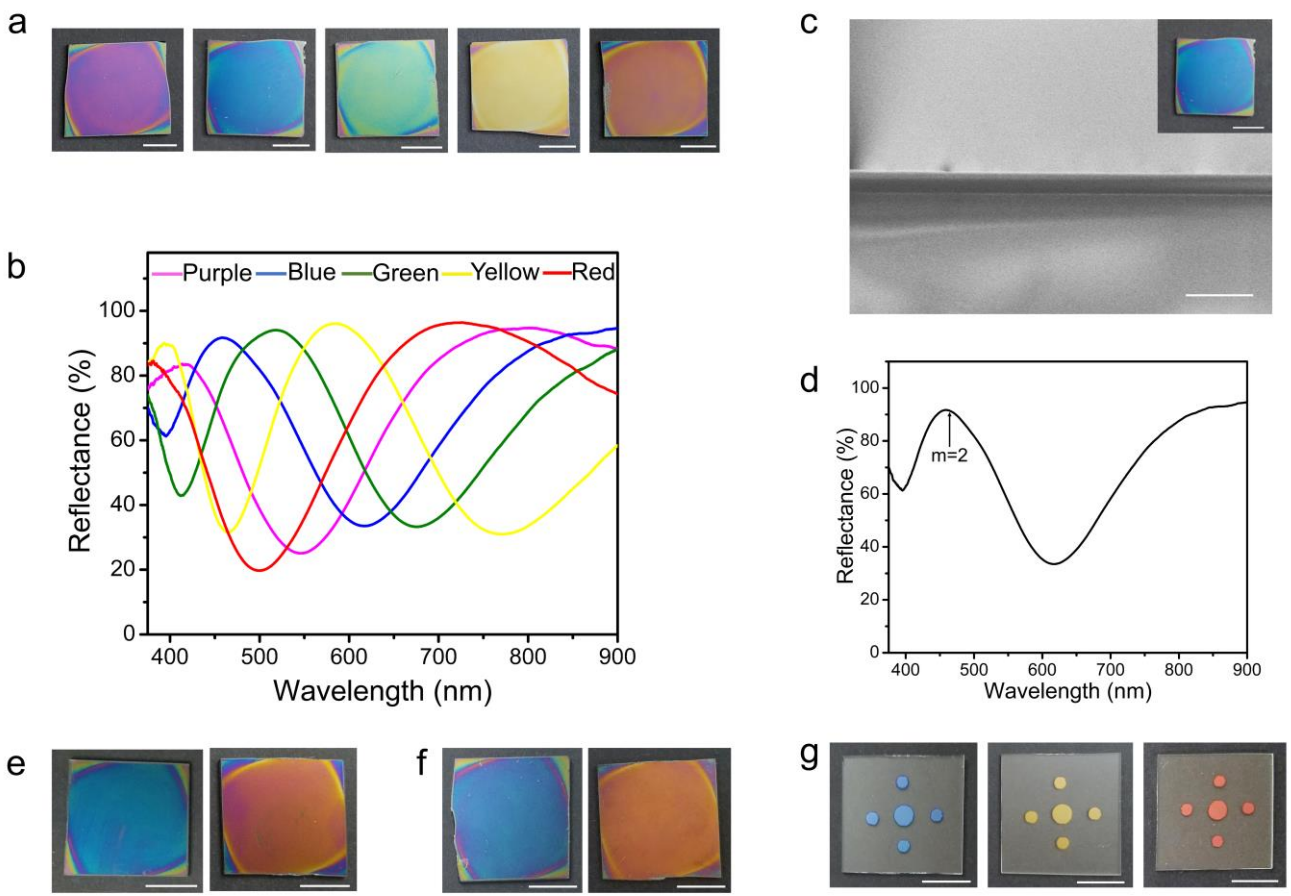
- Provisional Patent Application filed November 2018.

- Looking for a development partner to:
  - Fund macro-scale production
  - Assist with further testing
  - Provide feedback

Interference Coloration

Thin-film interference:

- Real-time, continuous, colorimetric RIC sensors for humidity, organic vapors, and temperature are demonstrated by using different stimuli-responsive polymers.
- Occurs in structures composed of one or more thin films, whose typical thickness is similar to the wavelength of light



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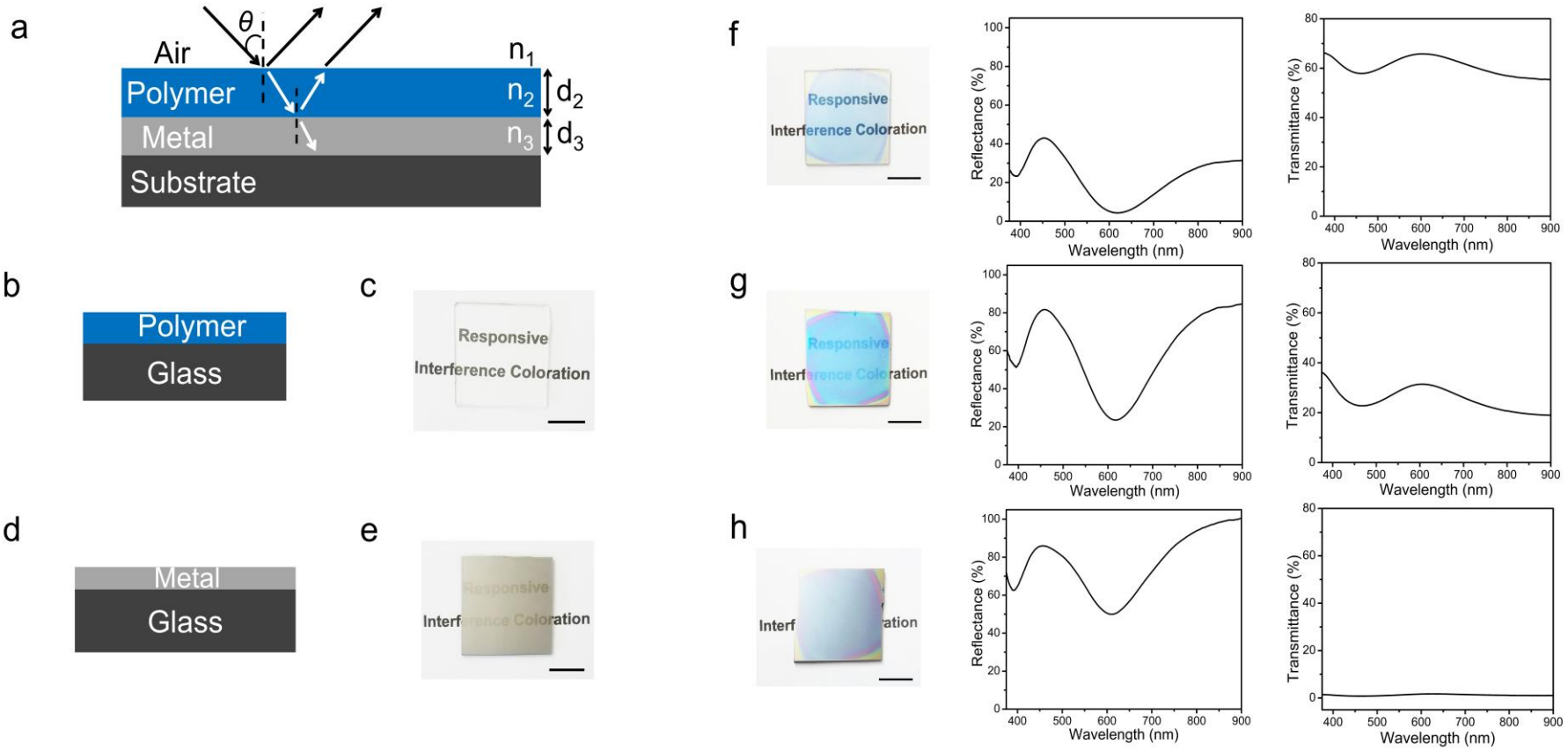
RIC Sensor Technology

A simple layering technique that exhibits structural color. The light response involves a versatile polymer layer backed by a thin adaptable metal layer on a substrate.



Research Design

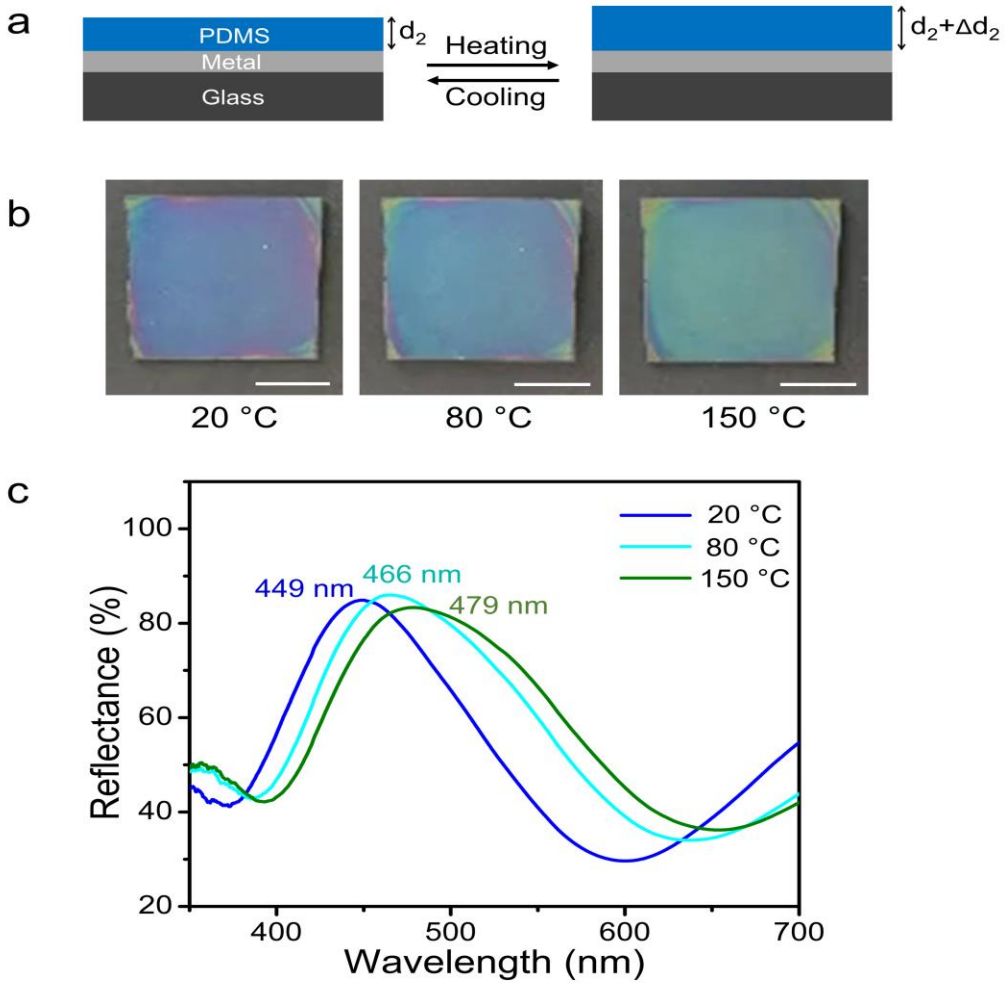
- The inventors have developed a scalable, affordable new approach to generate structural colors based on thin-film interference mechanism

- Applicable to both rigid and stretchable substrates
  - Versatile polymer layer choice: A wide range of thermoplastics, thermosets, and polymer composites can be used for rational engineering of stimuli-responsivity, stability
  - Versatile metal layer choice: A variety of metals and metal alloys such as iridium, silver, nichrome, etc. can be selected for target applications and manufacturing processes.
  - Versatile substrate choice: Our RIC design is applicable to many substrates, including glass.

- Generates full-spectrum of structural colors

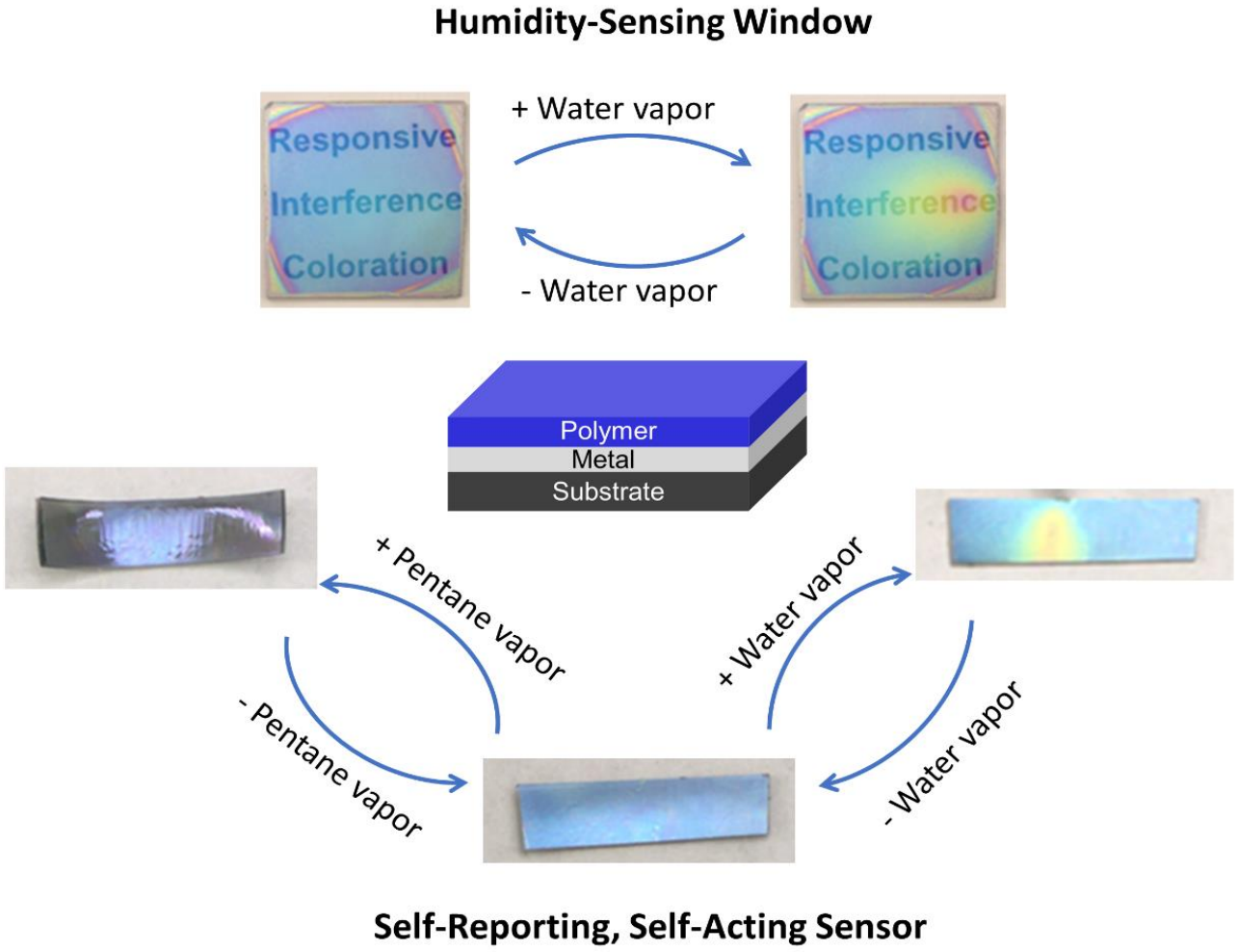
Stimuli-Responsive Structural Color

- Example: Color-change in response to temperature



Stimuli-Responsive Structural Color

Example: Color-change in response to humidity



Market Applications

What is needed are sensors that are all together cheap, fast, reliable, and easy to use. The inventors have developed technology in this space that provides this in almost any application!

Applications

- Environmental monitoring; humidity, temperature, chemicals, biomolecules, light, or mechanical forces.
  - **Humidity Sensors**
  - **Force Sensors**
  - **Temperature Sensors**
  - **Healthcare Sensors**
  - **Homeland Security**

Financial Benefits

Market

- *Humidity sensors* are extensively used in biomedical, food & beverage, consumer, industrial, agricultural, and environmental applications for detecting, monitoring, and sensing moisture
  - *Global Humidity Sensor Market is expected to reach approximately USD 1.88 billion by 2023 growing at a 15% CAGR over the forecast period 2017-2023*
- *Force Sensor* Market predicted to be worth 2.95 Billion with a CAGR of 6% by 2023
- *Global Sensor* Market is expected to garner $241 billion by 2022, registering a CAGR of 11.3 % during the forecast period 2016 - 2022. Sensor is a device that detects physical input such as light, heat, motion, moisture, pressure, or any other entity, and responds by producing an output.

Next Steps

- Find partner to:
  - Support macro-scale production methods
  - License and develop a final prototype for use in the field

- Results exist for a 3 layered sensor which responds (via change of color or shape) to an external stimulus, including but not limited to, water vapor, humidity, temperature, and light.

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