



# Reversible Antibody Trap for Selective Sensor Devices

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# Report Documentation Page

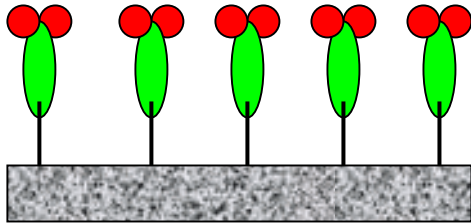
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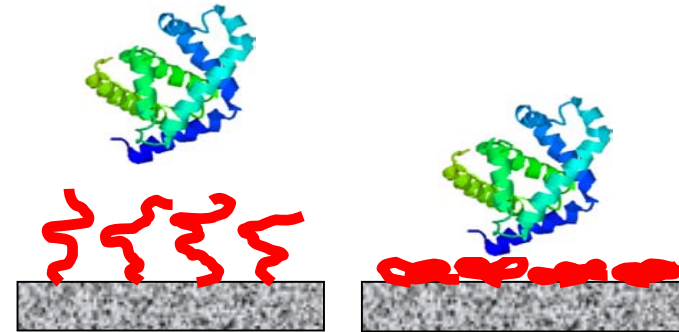
# Reversible Antibody Trapping For Selective Sensor Devices

Tethered Antibodies



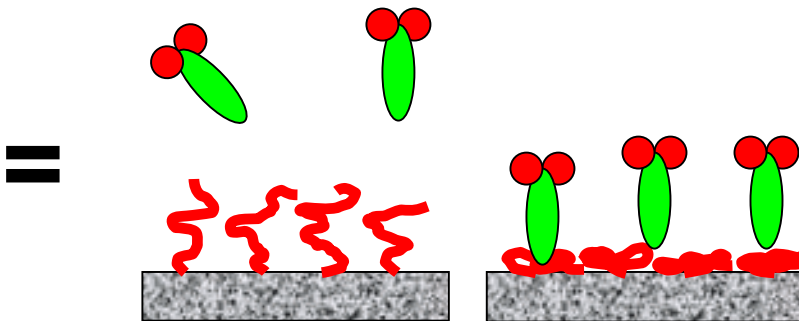
selective, but static

Switchable PNIPAM Film



programmable, but non-selective

Combined Antibody Trap

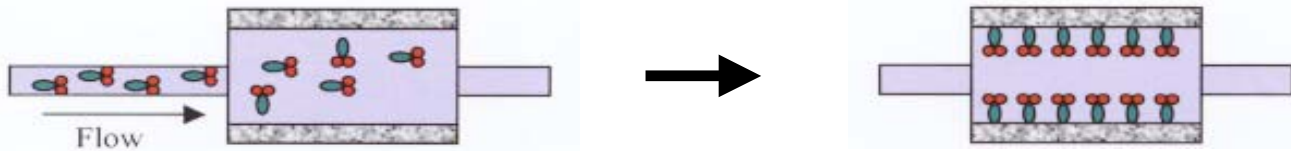


programmable and selective

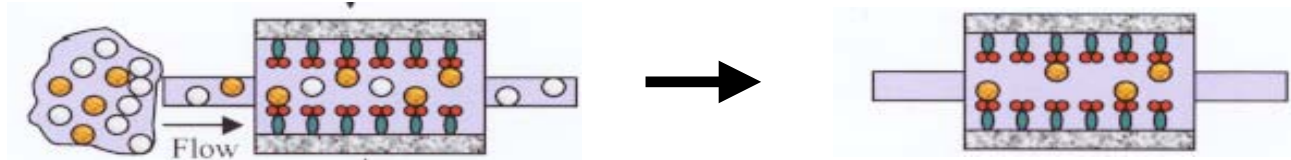
*New Laboratory Directed Research and Development Project for FY'04:*

- *Develop Programmable, Selective Biomaterial Interfaces.*
- *Integrate Bio-Active Materials into Sensors for Homeland Defense*

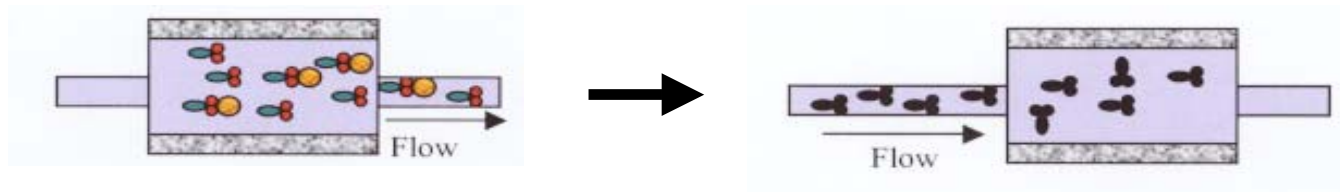
## Selective Surfaces via Antibody Trapping



**PNIPAM grabs antibodies to create highly selective protein monolayer.**



**Antibody layer captures bioactive agents.**



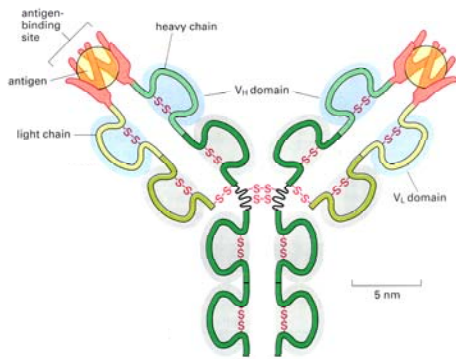
**PNIPAM releases active agents, resets to adsorb new proteins.**

### Materials Issues: Interactions of Proteins with Bioactive Surfaces

- 1) Reversibility of species adsorption/desorption.
- 2) Activity of antibodies in adsorbed films (packing, orientation).
- 3) Competition for active surface sites in complex biofluids.

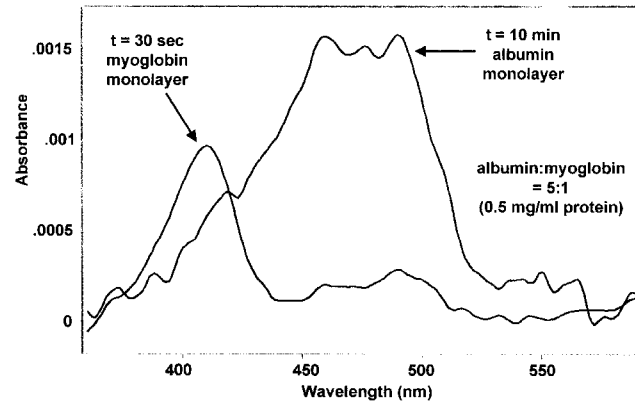
# Program Components

## Antibody Interactions



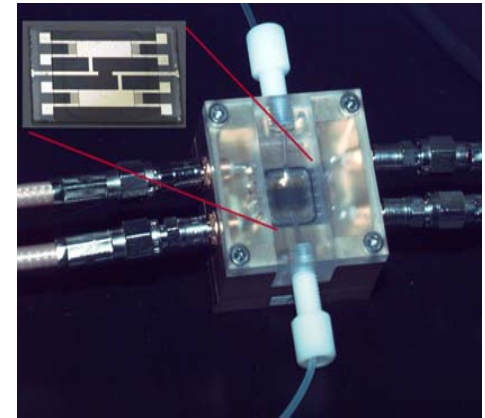
**Active Films**  
**Dale Huber**  
**Antibodies/Antigens**  
**George Bachand**

## Characterization



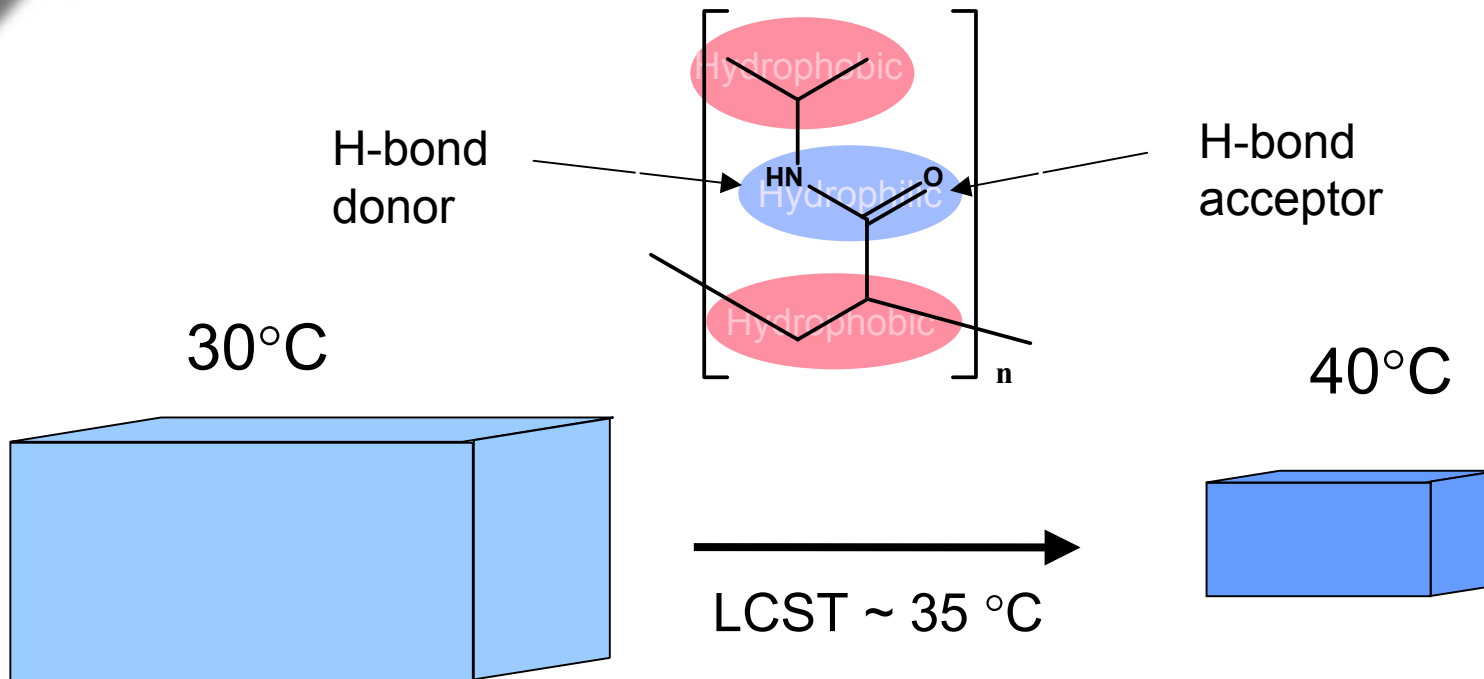
**Surface Spectroscopy**  
**Interfacial Force Microscopy**  
**Bruce Bunker**  
**Neutron Reflectivity (LANSCE)**

## Integrated Sensors



**Thermal Switching**  
**Ron Manginell**  
**SH-SAW Sensors**  
**Susan Brozik**

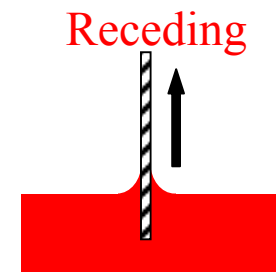
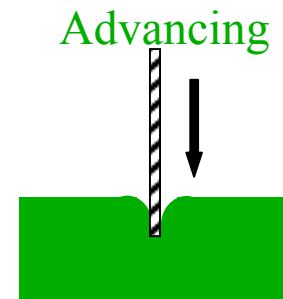
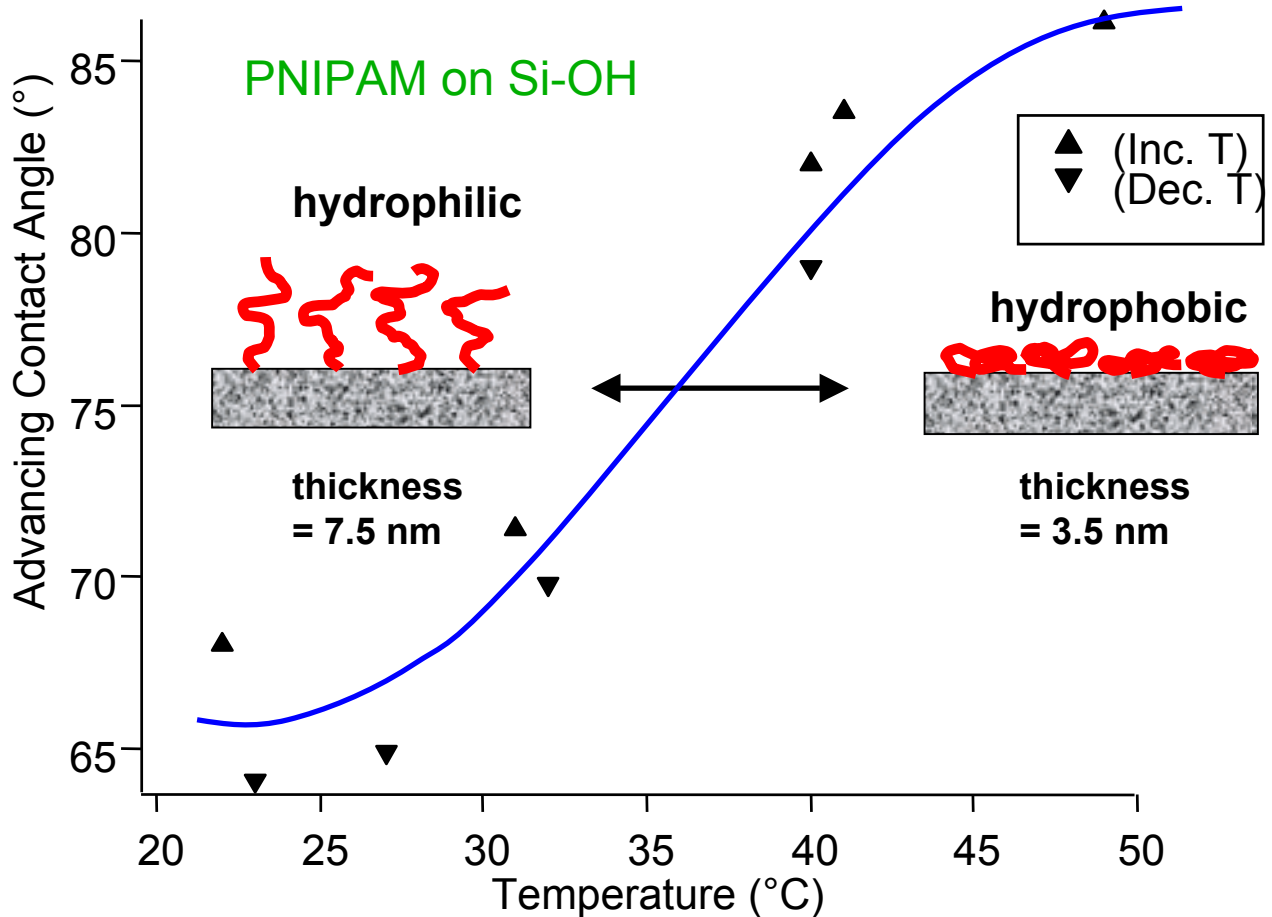
# Properties of Poly(NIPAM) Gels



- Swollen with water--heavily hydrogen bonded
- Hydrophilic surface
- Resists protein adsorption

- Hydrogen bonding disrupted--deswelled
- More hydrophobic surface
- Does not resist protein adsorption

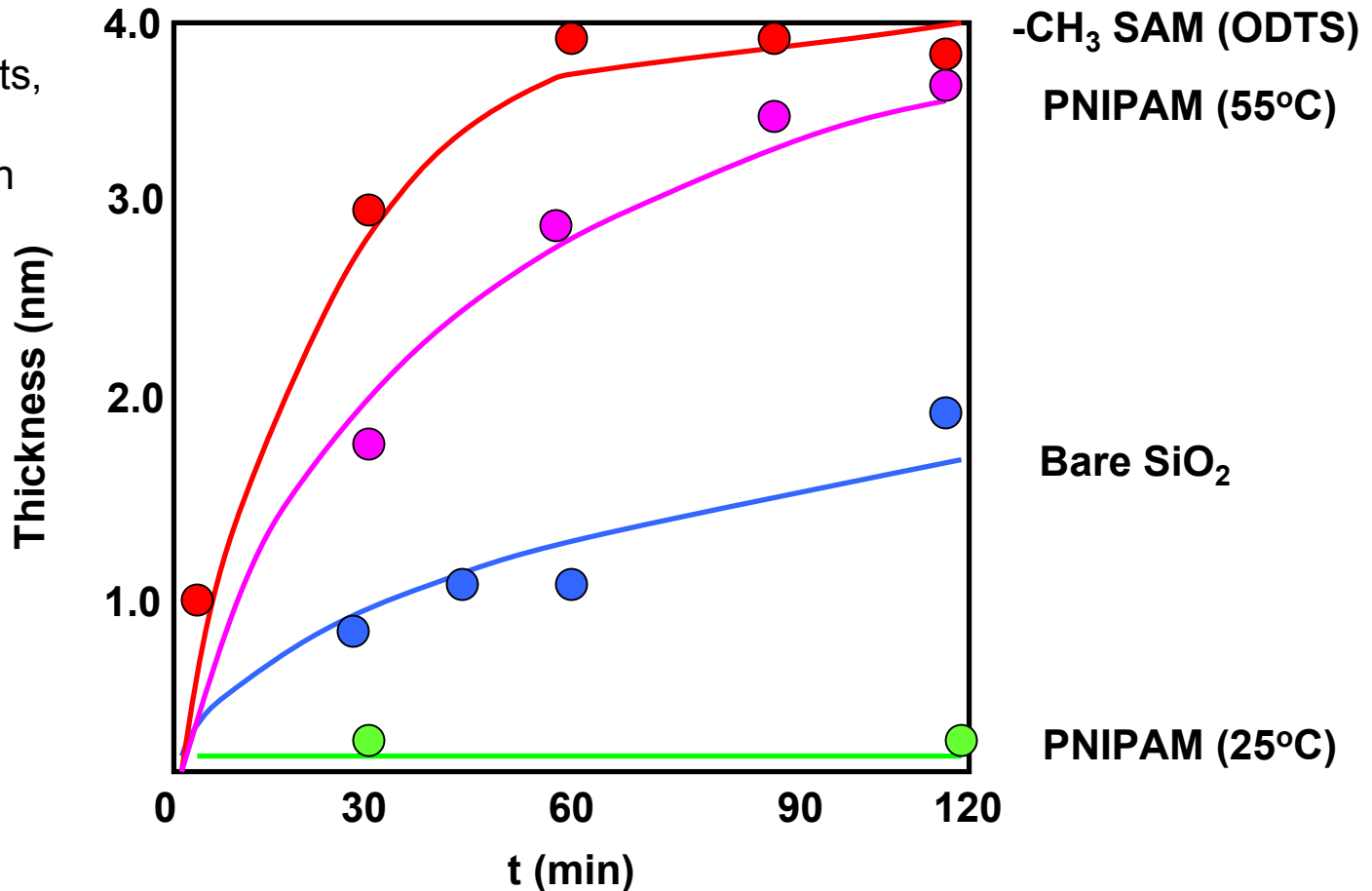
# Variable Temperature Contact Angle Measurements Show Reversible Switching in Tethered PNIPAM Films



- Receding contact angle constant at 40°C

# Trend: Hydrophobic Surfaces Adsorb Proteins Hydrophilic Surfaces Don't

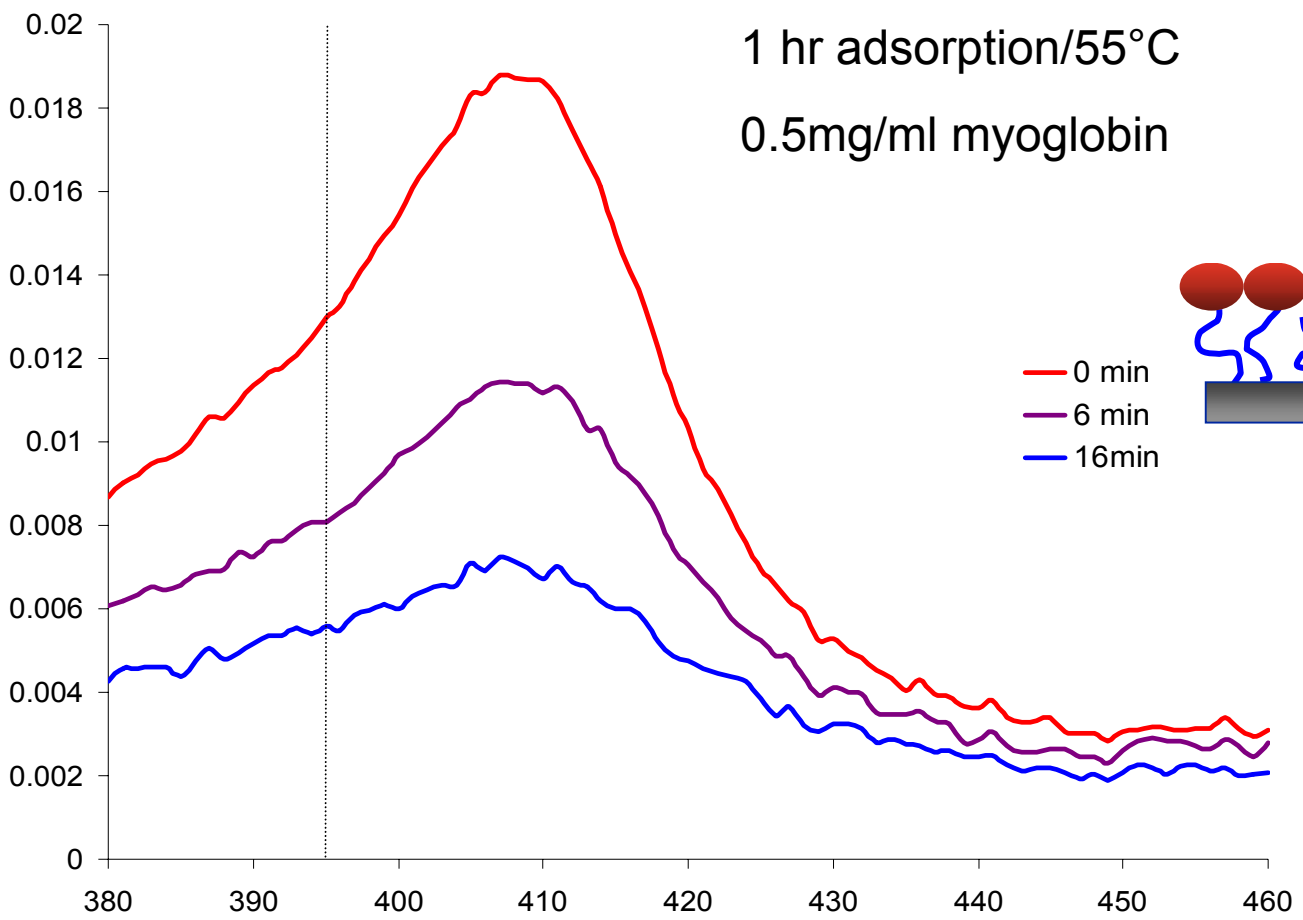
Ellipsometry Results,  
Human Serum  
Albumin Adsorption



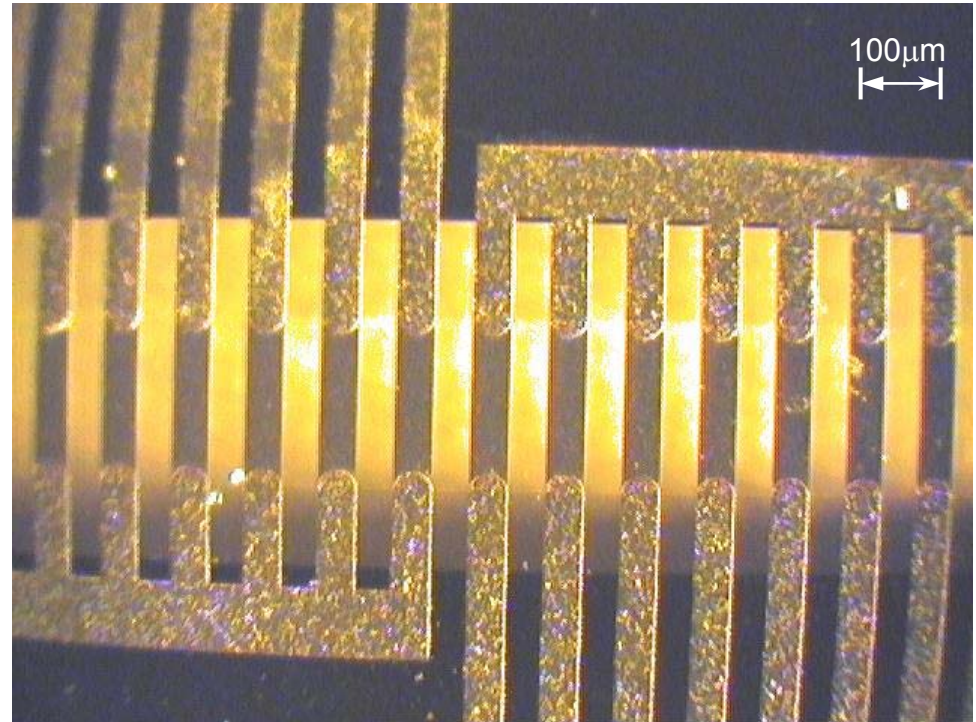
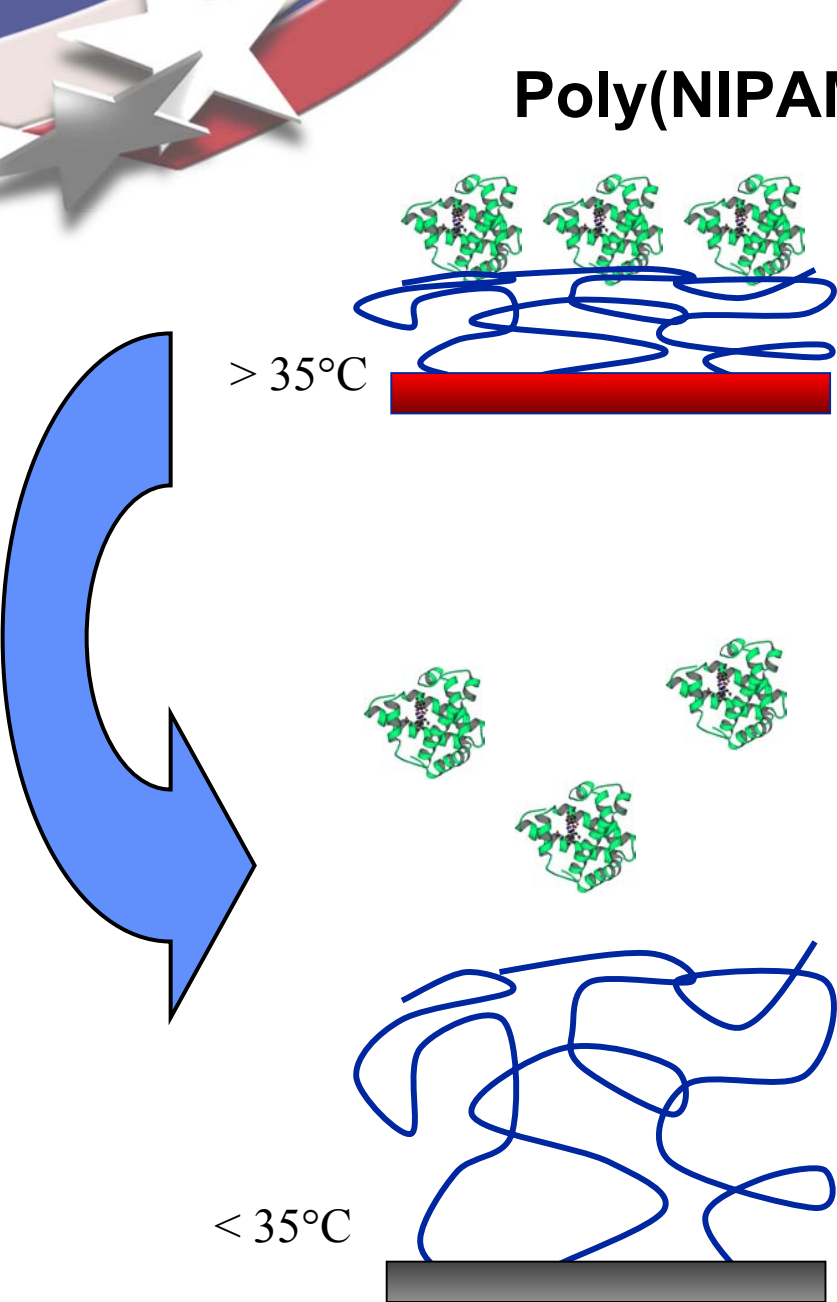
PNIPAM resists protein adsorption at 25°C.  
Adsorption is extensive on PNIPAM at 55°C.



# Native Myoglobin Desorbs When PNIPAM Switches



# Poly(NIPAM) Functionalized Microchip



**Programmed adsorption and release of proteins in a microfluidic device**

Huber, Manginell, Samara, Kim, and Bunker  
*Science* **301**, no.5631, p.352-354

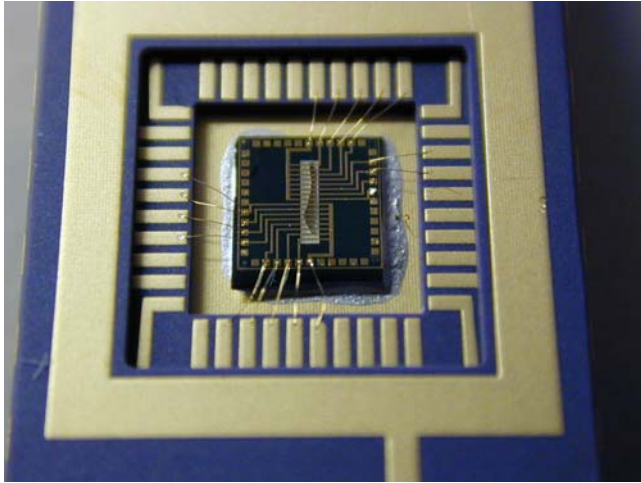


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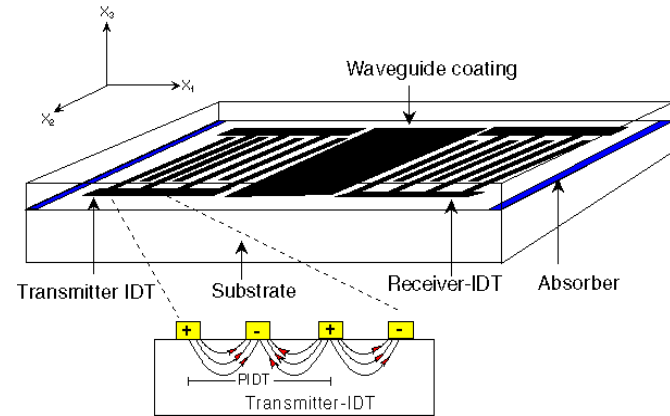
# Integrated Sensor Devices

## Thermally-Activated Protein Trap



## Shear-Horizontal Surface Acoustic Wave (SH-SAW) Sensor

+



**Rapid Switching:**  
Adsorption/desorption of  
protein monolayers in  $< 1$  sec.

**Exceptional Mass Sensitivity:**  
 $500 \text{ pg/cm}^2$  (0.15% IgG monolayer)  
(800 spores/ml detected)

**Materials Issues:** Integration of thermal and acoustic properties.

- 1) Acoustic Issues - PNIPAM on waveguiding, acoustics on phase transition
- 2) Thermal Issues -  $\text{LiTaO}_3$  behavior vs.  $T$ , thermal response times



# Preliminary Results

- Achieved total reversibility of protein adsorption on pNIPAM films.
- Can capture protein from very dilute solutions.
- Adsorption behavior of antibodies on pNIPAM is similar to other proteins, except there is a tendency to form multilayers.
- Antibody adsorption is reversible.
- Currently quantifying binding activity as a function of surface coating for a series of antibodies (native and engineered).
- Designs for integration of heating, SAW devices are being developed.

# Conclusions

- **Developing a small, reusable, highly selective sensor**
- **Can be programmed for just one antigen or a series of antigens by using a sensor array.**
- **May be programmed on the spot for any antigens for which antibodies are available**
- **After use, the spent antibodies can be flushed, and the same or different antibodies can be adsorbed.**
- **Can be integrated into existing Sandia Micro-chemlab platform.**

