

Detection of Patulin Mycotoxin using Molecular Imprinted Polypyrrole Modified Electrodes

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Mycotoxins

- Secondary metabolites produced by selected moulds
- Over 200 types identified
- Similar to antibiotics but toxic to plants, animals and humans

Mycotoxins

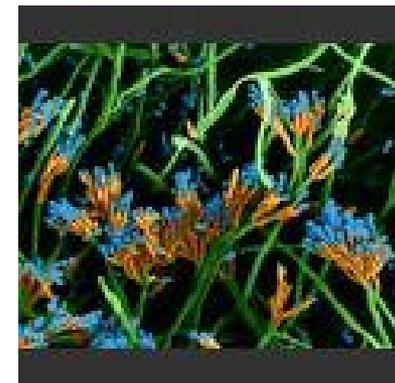
Food Safety

- Present on grains, pulses and spoiled fruit
- Animal production
- Crop production
- Acute and chronic illness in humans

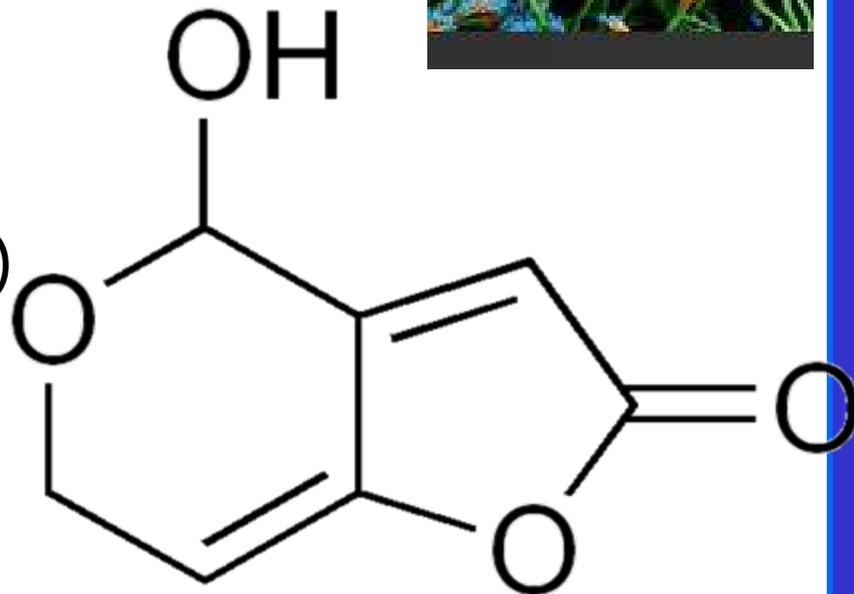
Bioterrorism

- Easy to produce in large quantities
- Stable to heat and acid
- Potent toxins

Patulin



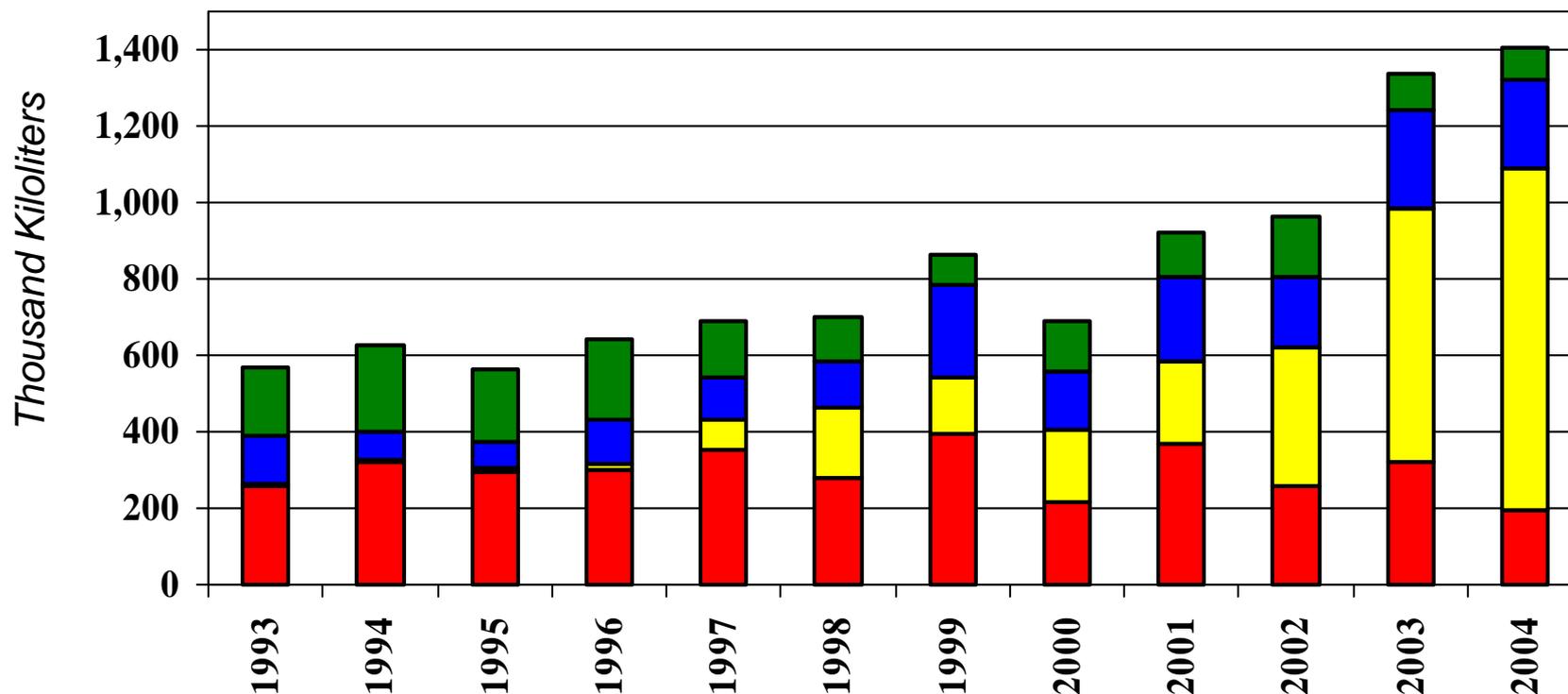
- *Aspergillus*
- *Penicillium*
- Apple juice (>400,000m T)
- Carcinogenic
- genotoxic
- Limit 25-50ppb
- LD₅₀ 15mg/kg (rat)



2-Hydroxy-3,7-dioxabicyclo
[4.3.0]nona-5,9-dien-8-one

U.S. Apple Juice Imports from Top Suppliers

■ Argentina ■ China ■ Chile ■ Germany



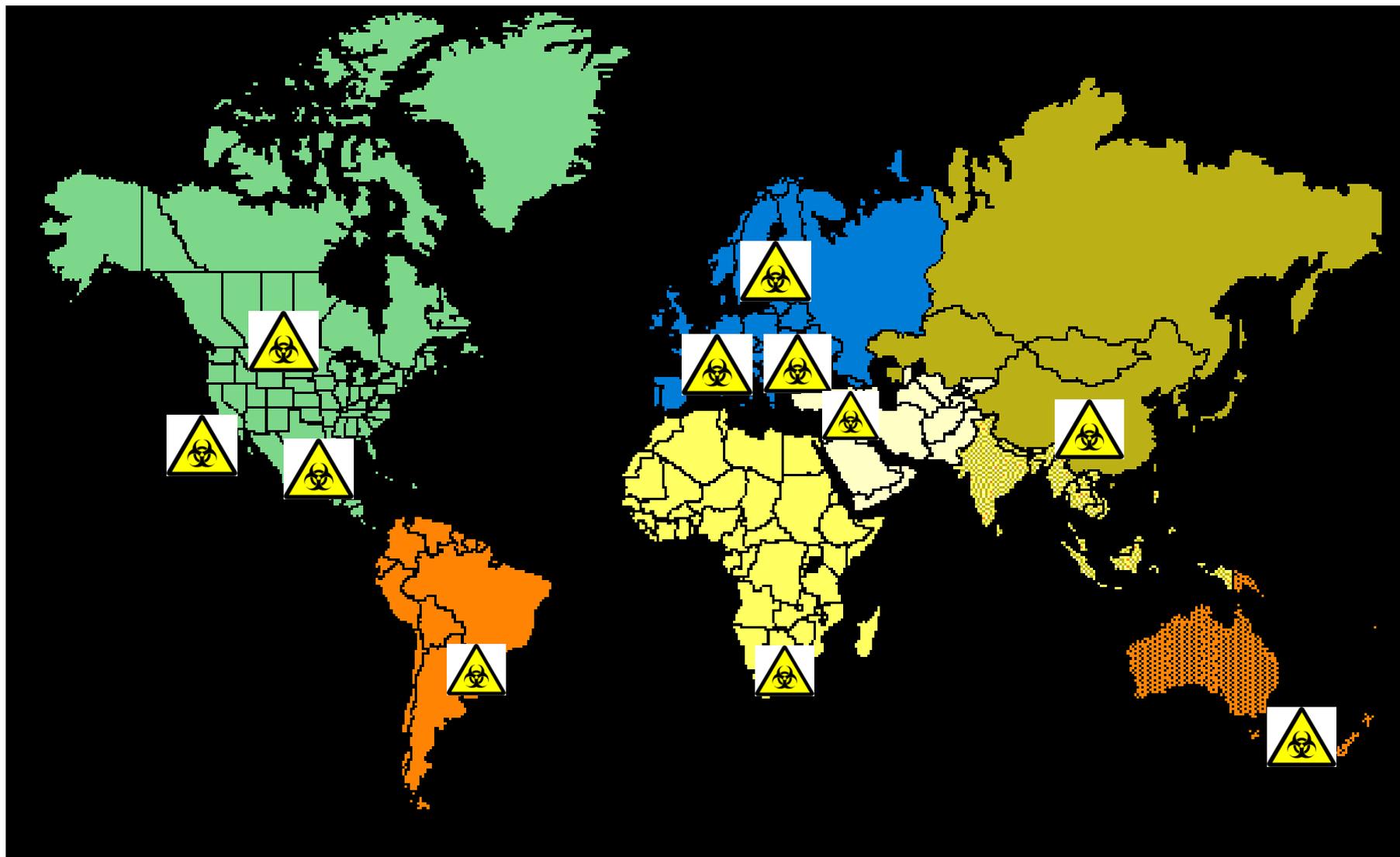
Calendar Years NATIONAL CENTER FOR

Source: U.S. Department of Commerce, Bureau of the Census.

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Patulin Hot-Spots



Patulin Analysis

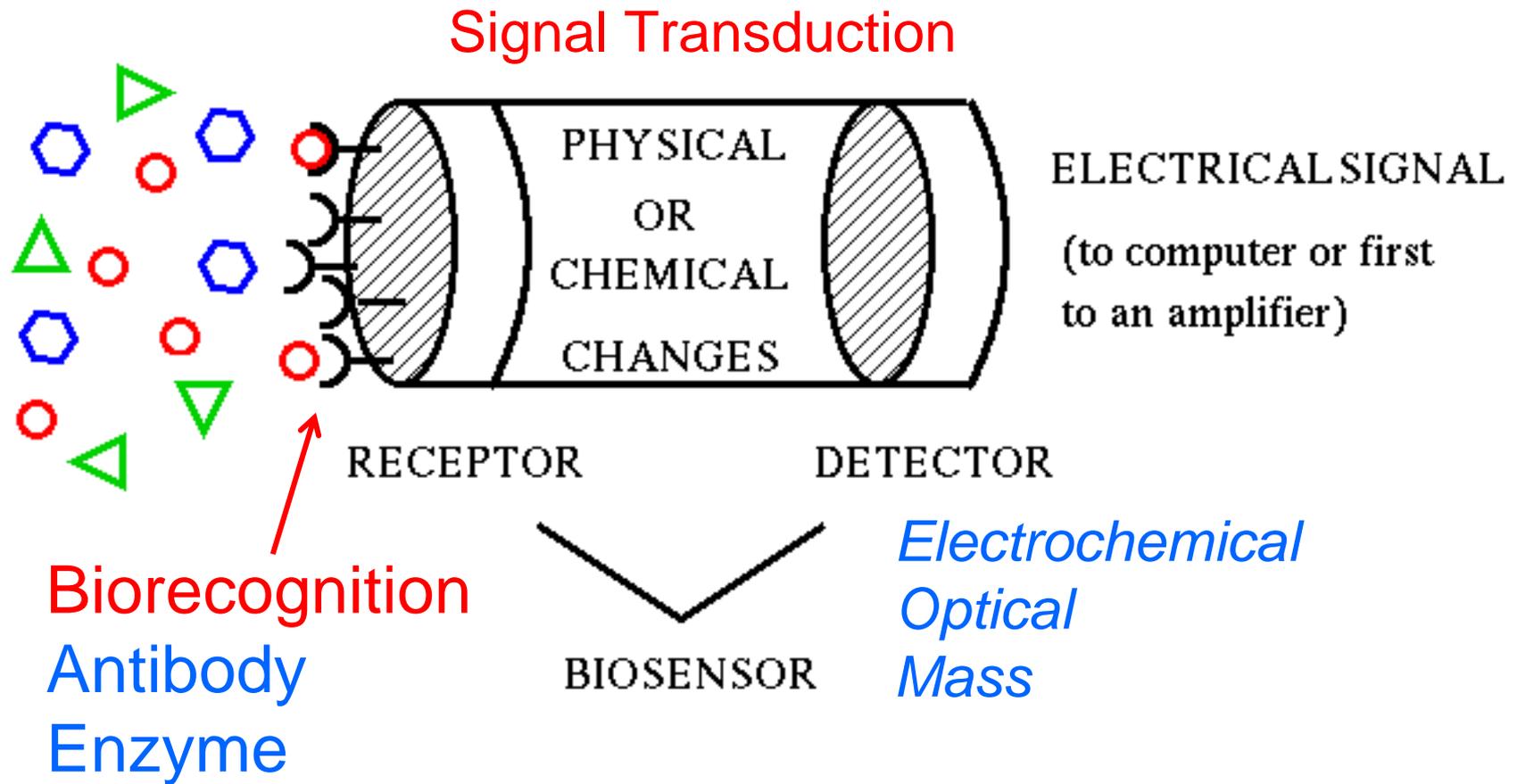
Laboratory Based

- HPLC
- Expensive
- Time consuming (10 days)
- High degree of technical expertise
- Sensitive 10ppb

On-site testing

- ELISA
- Expensive
- Small sample volumes (μ l's)
- Low sensitivity
- Multi-step protocols

How to Build a biosensor



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Biorecognition

Biological

- Selective
- Expensive
- Difficult to produce large quantities
- Un-stable



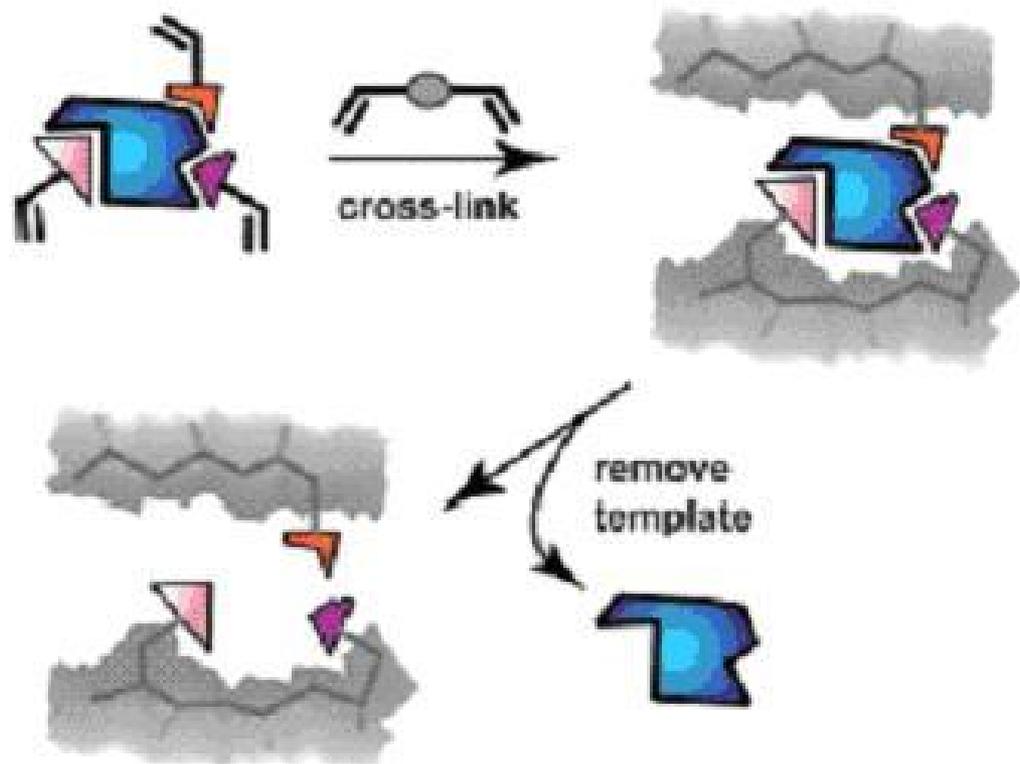
Molecular Imprinted Polymers

- Cheap
- Easy to fabricate
- Stable
- Compatible with mass manufacture
- Versatile

Molecular Imprinted Polymers

Artificial antibodies or Plastic antibodies

Rapidly expanding area



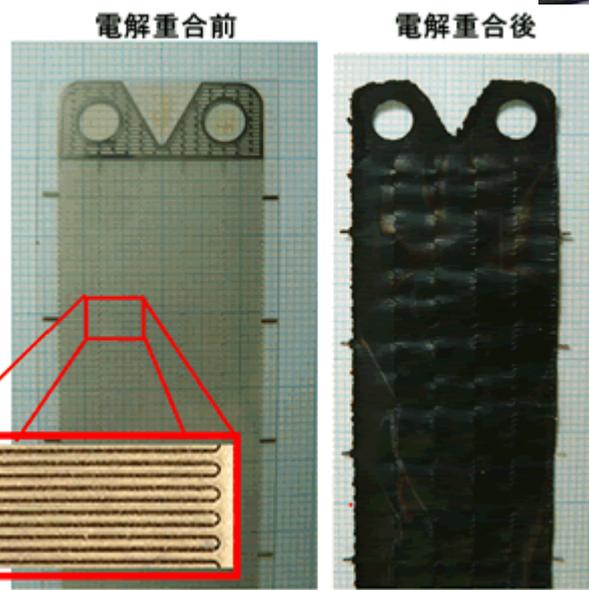
Schematic presentation of the synthesis of MIP

Patulin Imprinted Polymers

- Normal MIP polymers are inert and used for solid phase extraction.
- Conducting polymers
 - Synthetic metals
 - Semi-conductors
 - Easily fabricated by chemical or electrochemical polymerization
 - Memory effects

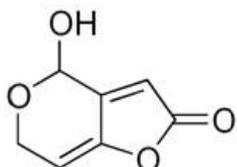
What are Conducting Polymers used for?

- Stealth (Radar Absorbing)
- organic light-emitting diode
- Fuel cells
- Actuators
- Organic computers
- Sensors

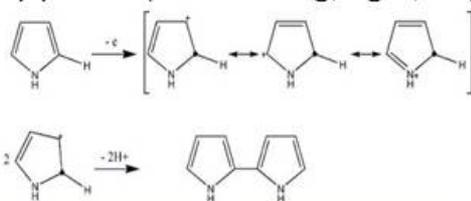


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Patulin template



Electropolymerization of pyrrole (0.85V vs Ag/AgCl; 70 μ C)



Glassy Carbon Electrode

Polypyrrole

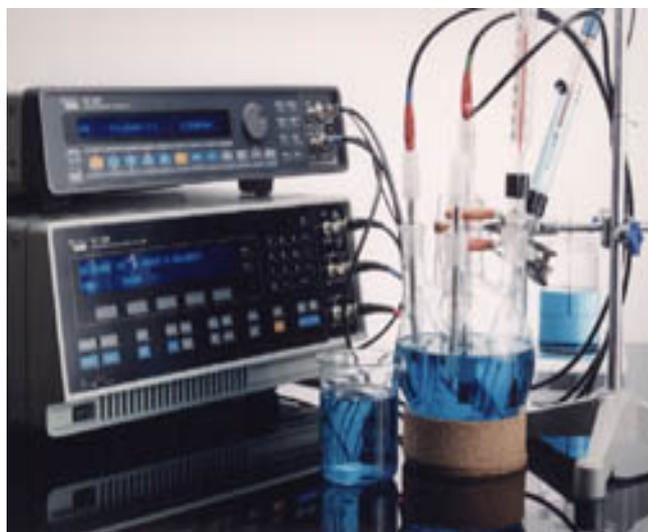


Patulin template removal by soaking in triethylamine (TEA)



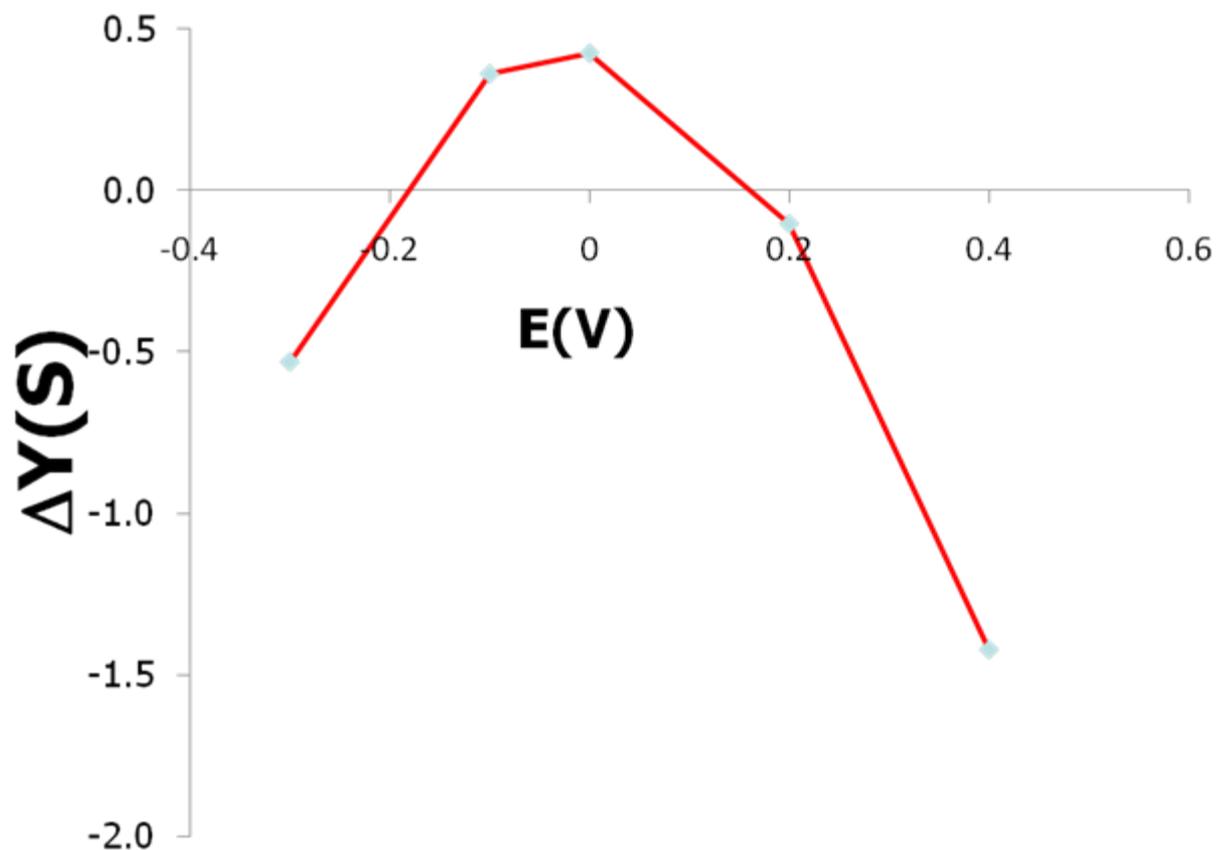
Patulin imprinted polypyrrole modified electrode

Expose sensor to patulin and measure impedance change



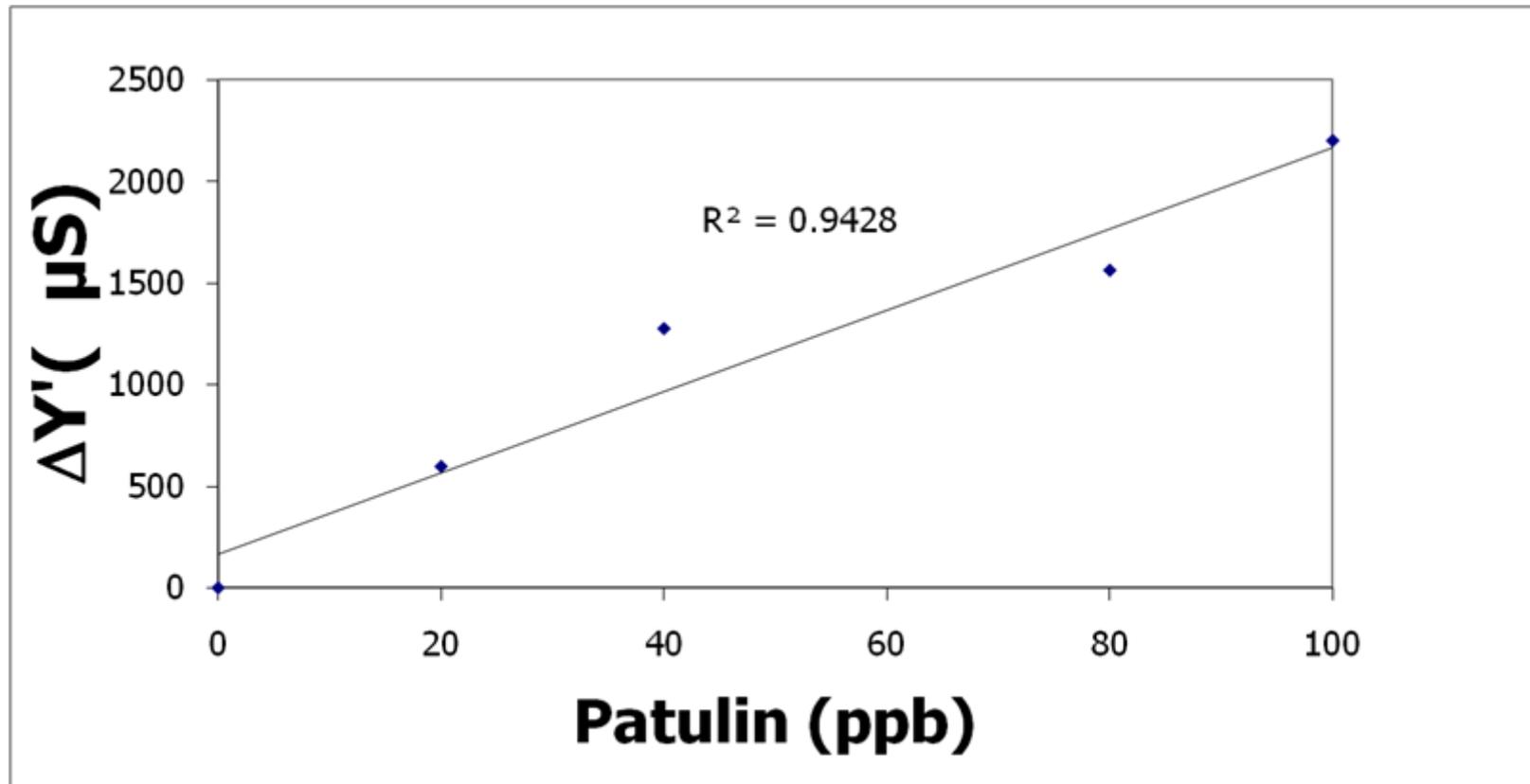
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Response to Patulin



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Response to different patulin concentrations.



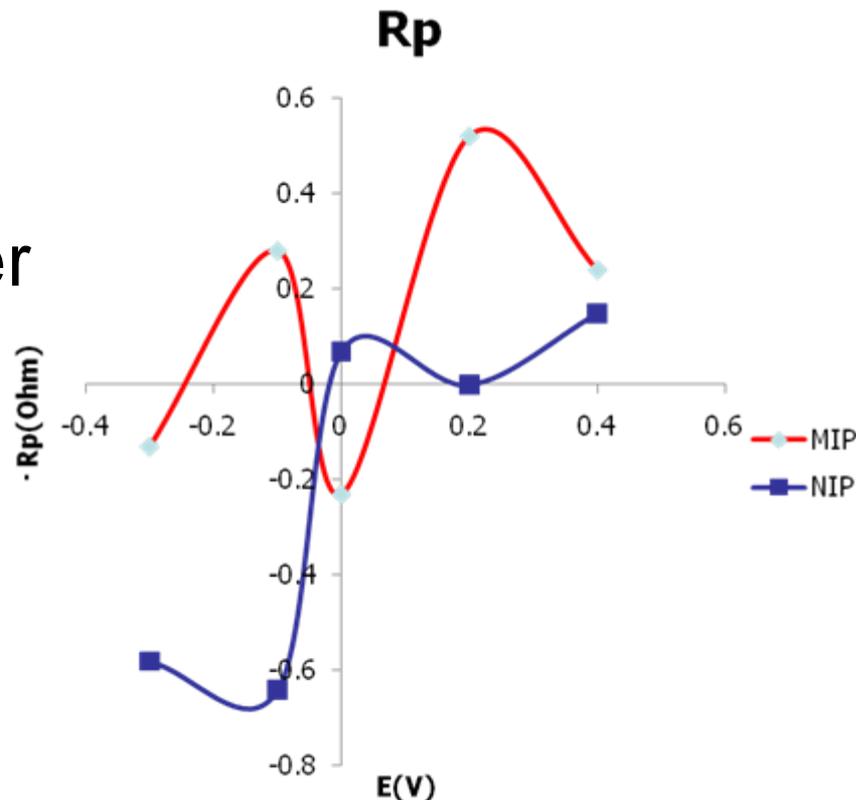
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“Imprinting Effect”

- Higher responses ($> \times 8$ ideal) compared to non-imprinted films.
- Regeneration
- Selectivity over structurally similar analogues

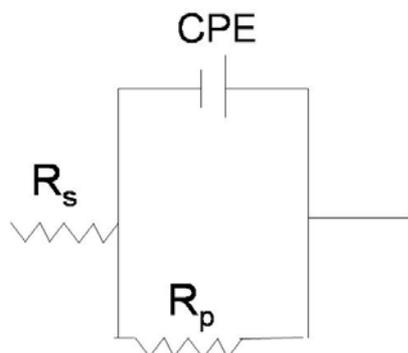
MIP: Imprinted polymer

NIP: Non-imprinted polymer



Equivalent circuit analysis

Constant Phase Element



R_s = Solution Resistance

R_p = Polymer Resistance

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Significance of the Research

- Sensitive, reagentless, sensor for patulin detection
- Multi-analyte arrays on a single chip
- Tool to facilitate on-site testing and rapid corrective action
- Smart materials that can sequester toxic substances

Research needs

- Elucidate the interaction between patulin and polypyrrole
- Sensor performance in real-sample matrices
- Extend imprinting of other mycotoxins
- Integration of the sensor with Solid Phase Extraction and hand-held electronic devices

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