Cerium Oxide Paper Sensors for Hydrogen Peroxide and Glucose Detection

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Cerium oxide one of the newest of biomaterials

PERFORMANCE BENEFITS:
Traditional
- Polishing
- UV Protection
- Catalyst

Newly discovered:
- Cell regeneration
- Radical scavenging
- Oxidative stress remediation
- Biosensors

FDA-approved for use in contact lenses

Redox-cycling of cerium 3+ and 4+
Colorimetric reaction of cerium oxide with hydrogen peroxide

Effect of the NPs’ size

[Graph showing absorbance at 450 nm vs. hydrogen peroxide concentration (mM)]

110 mM H$_2$O$_2$

100 nm

20 nm
Fabrication of hydrogen peroxide paper sensor

Fabrication of the ceria laded paper using silane hydrogel composite to achieve higher binding capacity.

Calibration with Hydrogen Peroxide

Testing in human serum

Blank (water)
10 mM H₂O₂ in water
10 mM H₂O₂ spiked human serum
Ceria-glucose enzymatic sensor

Design concept:

Glucose + O₂ → Glucose oxidase → gluconolactone + H₂O₂

Possible detection of other important physiological markers:

Lactate + O₂ → LOX → pyruvate + H₂O₂
Glutamate + O₂ → GluOX → α-ketoglutarate + NH₃ + H₂O₂

Glucose oxidase was immobilized onto the ceria laded paper using silane/chitosan composite to achieve higher binding capacity for the enzyme.
Colorimetric paper-sensors for glucose

Calibration with Glucose

0 2.5 5.0 10 50 100 mM

Calibration in human serum using GOX modified ceria paper

y = 0.4717x + 360.4
R² = 0.9945

Blank (water)
10 mM glucose in water
10 mM glucose spiked human serum
Applications

Overseeing water treatment
Evaluation of the antioxidants

$\text{H}_2\text{O}_2$  Inflammation marker
$\text{H}_2\text{O}_2$  Indicator of level of oxidative stress
Can be adapted for detection of Glucose, Lactate, Glutamate after adding corresponding oxidase
Latest tests indicate this sensor can detect superoxide radicals
Conclusions

• Ceria-paper sensor provides new colorimetric reagent-less detection of hydrogen peroxide
• Response time of only few seconds
• Inexpensive
• High storage stability – no biological reagents
• Can be combined with oxidase enzymes for detection of glucose and other molecules
Thank You