KANSAS STATE UNIVERSITY | Department of Entomology

Detection of Nitrate and Nitrite using a Micro Silica Sensor

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Background

Nitrate/Nitrite

- Nitrate and nitrite contaminations in drinking water cause major health concerns, such as blue baby syndrome, and contribute to gastric cancer
- Nitrate/Nitrite is of environmental concern, causing accelerated algae blooms and acidifying the soil
- A significant source of nitrate/nitrite is from agricultural fertilizers and industrial discharge

Knowledge Gap in Detection

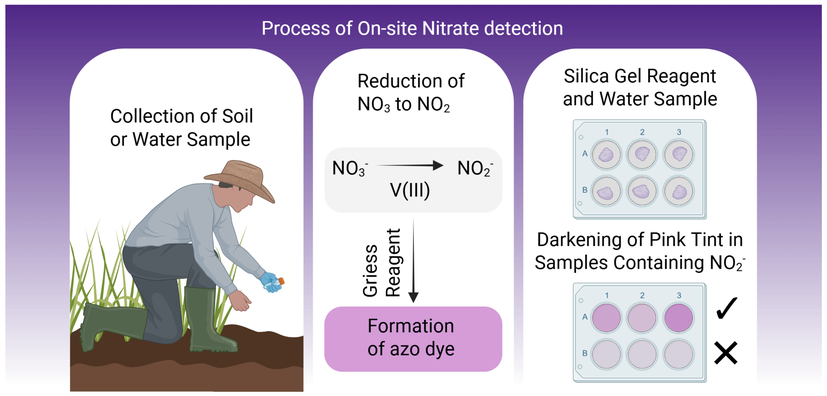
- Current EPA methods require significant turnaround times and cumbersome laboratory equipment
- Colorimetric sensors tend to have sensitivity and/or selectivity issues

In-Field Colorimetric Detection

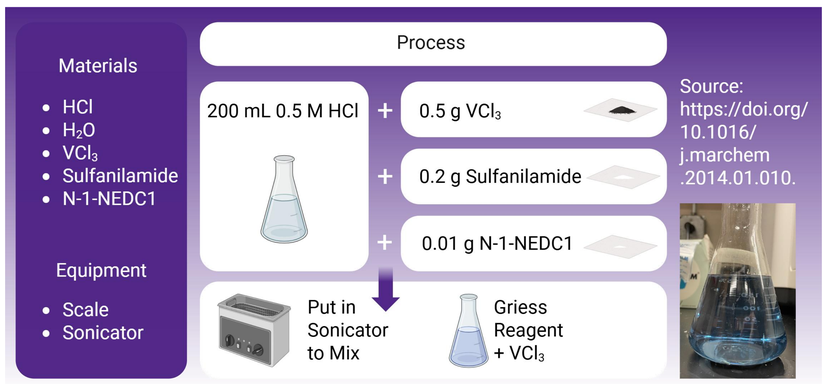
- Proposed here is a proof-of-concept on-site sensor using a Griess reagent loaded on silica porous material, enabling the detection of nitrite and nitrate in the field
- EPA currently uses Griess reagent in the laboratory to detect nitrite

Impact and Application

- A development of a new Griess+ V(III) colorimetric sensor for nitrite and nitrate with potential usage in the field.
- Rapid on-site detection of nitrite and nitrate to safeguard water security

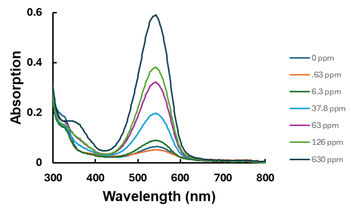


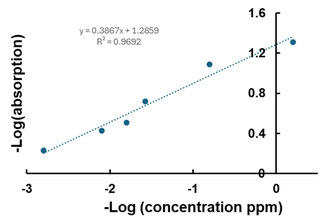
Procedure for Nitrate Detection Reagent



Calibration Curve to Nitrate and Nitrite

Nitrite





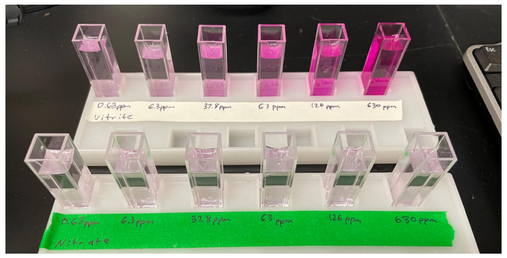
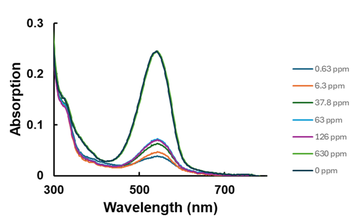
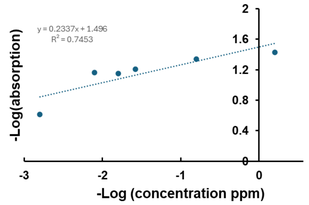


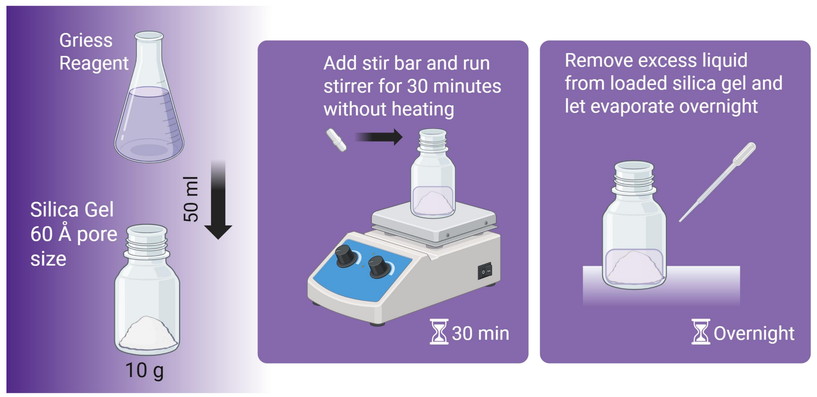
Photo: Nitrate (top) and Nitrate (bottom) of increasing concentration with Griess Reagent used to create calibration curves

Nitrate

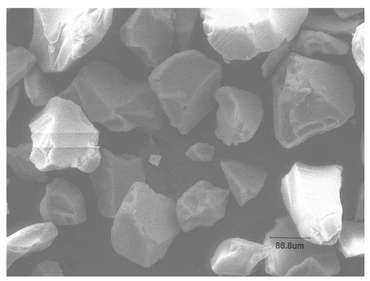




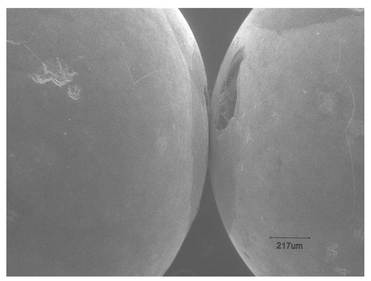
Silica Loading Procedure



SEM Images of Silica loaded with V(III) +Griess Reagent

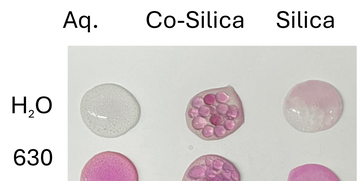


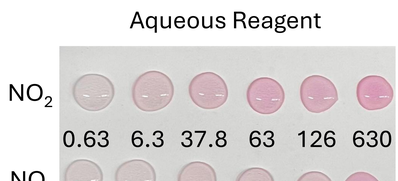
Silica loaded Material



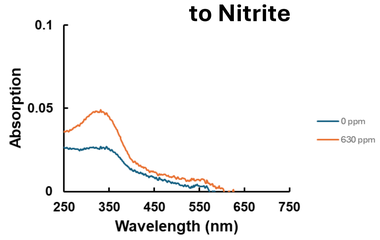
Co-Silica loaded Material

Silica Response to Nitrite and Nitrate

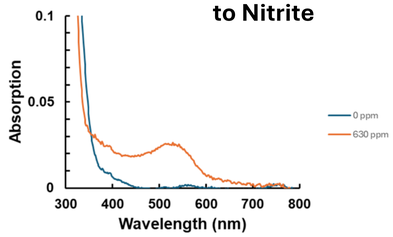




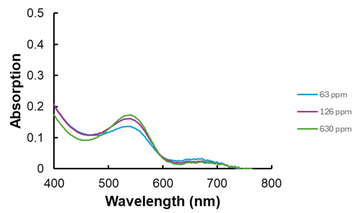
Silica gel response to Nitrite



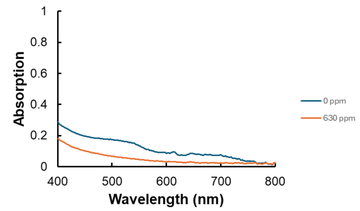
Co-Silica gel response to Nitrite



Silica gel response to Nitrate in soil



Co-Silica gel response to Nitrate in soil



The silica gel responded to nitrate in the soil, while the Co-Silica gel did not respond to nitrate in the soil. This may be due to the leaching of the Griess reagent and V(III) from the Co-Silica gel, given the size difference between the Co-Silica gel and Silica gel alone.

Conclusions

- Successfully designed a solid-state nitrate/nitrite sensor
- Co-Silica gel did not detect nitrate; however, Silica loaded with V(III) and Griess reagent was able to detect nitrate
- A calibration curve was developed using V(III) + Griess reagent for nitrite with a R^2 value of 0.95, the R^2 value for nitrate was 0.76

Acknowledgement

Kansas Water Institution
Graphics Created in BioRender