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Methods and Devices for the Quantification of Ozone

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Methods and Devices for the Detection and Quantification of Ozone

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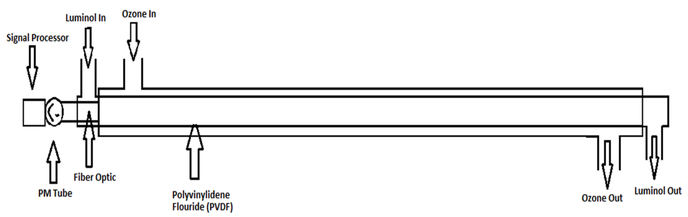
GOALS AND PREVIOUS WORK

The goal of this project is to develop small, rugged, and low energy consumption devices that can act as ozone detectors in critical spacecraft circuitry. Previous work in this lab has resulted in development of the sensor shown below. The polyvinylidene fluoride (PVDF) the inner tube is made of has a large free volume that allows easy transport of ozone through it. The very low index of refraction of the amorphous Teflon lining the inside of the PVDF tube allows it to act as a liquid core waveguide when filled with an aqueous solution. In operation the inner tube was filled with an aqueous solution of luminol. Gas samples containing ozone were allowed to flow through the larger tube. Ozone then diffused through PVDF causing fluorescence of the luminol. The light was then routed to a photomultiplier tube by a fiber optic. While this sensor is indeed inexpensive, rugged, and sensitive (7.33 ppb), it is too large for the intended application.



Perviously Developed Ozone Sensor

Miniaturization of this detector has been attempted and has found that the decrease in sensitivity rendered it unacceptable. As a result, the focus of the first part of the project consists of an exploration of substances that react with ozone producing a measurable change (eg color change, fluoresces, transmittance etc.) on which to base the sensor.

CURRENT WORK

Investigation of alternative designs that allow miniaturization. All based on bleaching of indigo carmine by ozone.

- **Vesicles**
  - Made by dropping an aqueous solution of surfactant into a non-polar solvent (heptane or mineral oil)
  - Non-ionic and anionic surfactants were studied.
  - Vesicles used able to contain a solution but not sufficiently stable enough to attach to a fiber optic.

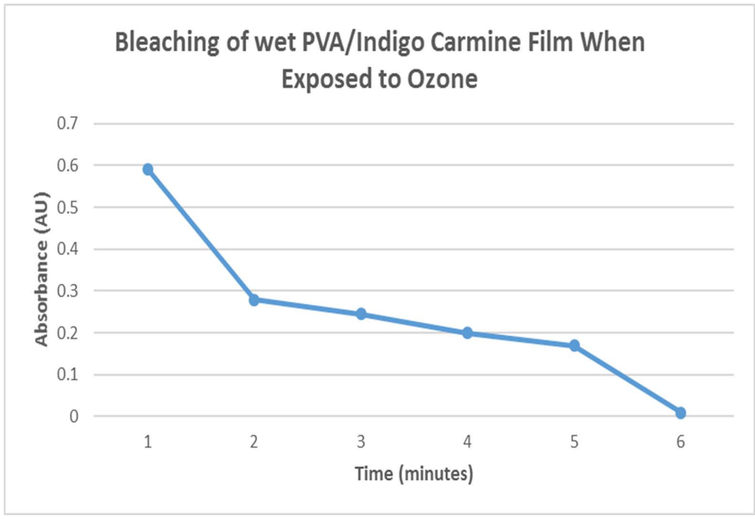
- **Cross-Linked PVA spheres**
  - Made by dropping an aqueous PVA/indigo carmine solution into sodium borate solution.
  - Stable in water.
  - Quickly bleached when ozone added to the water.
  - Stable when dry but resistant to bleaching even when exposed to ozone for an extended period of time.

- **PVC**
  - Films, membranes, envelopes.
  - Plasticized and un-plasticized.
  - Only permeable when wet.

- **Indigo Carmine/Paper**
  - Aqueous indigo carmine solution absorbed into filter paper and dried.
  - Exhibited rapid and significant bleaching when wetted with water or ethylene glycol and exposed to ozone.
  - Non reactive with ozone when dry.

CURRENT WORK CONTINUED

- **PVA Films**
  - Made by drying aqueous PVA/indigo carmine solution on glass surface.
  - Dry film resistant to bleaching when exposed to ozone.
  - Wet film bleaches quickly in the presence of ozone. (See plot below)



FUTURE WORK

- Continue the study of PVA/indigo carmine films and spheres and development of methods of incorporating them into a device for sensing ozone.
- Investigate additional ozone responding coatings for the QCM.
- Revisit original design and investigate methods of miniaturization such as incorporation of fiber optics containing fluorescent dye for signal amplification.