Microwave Monitoring of Microbial Degradation with UV Sources

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Creating an Index of Cell Viability

Electrical Properties of Cells –
Valuable information in the measurements of a cell’s electrical resistance and impedance

1) During cell death, a sharp decline of electrical **resistance** is observed
   - Results from pore formation in the membranes of dead cells through which ions can penetrate
   - Leads to a change in ionic composition in the cell, water
   - **Resistance** is a property of a material that quantifies how strongly that material opposes the flow of electric current.
   - A low resistivity indicates a material readily allows the flow of electric current – more ions in the cell lead to readily ability to flow electric current, leading to decreased electrical resistance

2) Necrosis (cell death) of plant tissue
   - Leads to a change in measurements of **impedance**
   - 10–20% increase in high frequency conductivity

Results

Measuring a waveguide’s dielectrics properties
Capturing the raw data via our module produces for microwave spectroscopy
Demonstrate Feasibility of metrology for UV-degradation of biomolecules (yogurt cultures) adsorbed on glass substrates

- Resistance (R)
- Inductance (L)
- Capacitance (C)
- Characteristic impedance (Zo)
- Propagation constant (Γ)
UV-degradation of Yogurt Films on Glass in Air

Experimental Setup

SEM of Yogurt

SEM (scanning electron micrograph) of Streptococcus thermophilus (yellow) and Lactobacillus bulgaricus cells (blue) in yogurt. Streptococcus thermophilus is a lactic acid bacterium found in fermented milk products, used in the production of yogurt.

http://www.magma.ca/~scimat/FoodStruct_1982-93.html
Electrical Resistance as Index of Cell Viability

Death of biological cells ➔ Reduced Electrical Resistance

➢ (as a result of pore formation in the membranes of dead cells and change in water content)
➢ BDS detects change in electrical properties biomolecules in thin film

- Cells die by (i) starvation (out of substrate in about 4 hrs.)
- (ii) UV-Ozone (O3 ) does not kill all the bacteria in the Yogurt Film
- (iii) or (ii) by photolysis (in about 2 hours) - cell death is accelerated by UV-photolysis from 4hrs to 2 hrs.
- Cells that survive UV-irradiation eventually will die by starvation.
Gaps and Limitation

- Use modern calibrated light sources
- Light monitor to determine how much light is hitting the samples
- Uniformly irradiate samples in a controlled environment (atmosphere, temperature, humidity)
- Sample-to-sample reproducibility (i.e., uses cell culturing wells)
- Serial Measurement time overhead for samples in a batch

Next Steps

- Comprehensive Chemical analyses of intermediate and final products
- Test theory and concepts on with Bakers’ Yeast
- Define parameters for HAI mitigation efficacy
- Distance and angular dependence of irradiation efficacy
- Predictive models for UV-photolysis (e.g., COMSOL models)

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