# Spectroscopy and biorefinery

This page contains a description of a student research lab project. To read more about the student research lab concept, go to the full description.

### Introduction

The conversion of raw materials into value-added products, including food, feed and pharmaceutical ingredients, polymers, materials, platform chemicals and fuels is the core of the chemical and bioprocess industry. In the last decades, fossil resources were used as the primary feedstock for developing chemical processes and transformations. Today, sustainability and environmental friendliness has become an important issue due to the significant climate change and fossil resources depletion that have encouraged the paradigm of "Biorefineries" as the response to sustainable growth. The concept of biorefineries includes the production of chemicals and fuels by incorporation of **biomass transformation bioprocesses.** The main advantages of biorefineries are variations in biomass components and side streams that can maximize the value derived from biomass feedstock. Thus, biorefineries can produce low-volume but high-value chemical products and/or high-volume low-value products.

The majority of Biorefineries are based on biochemical transformation of biomass feedstock into low- and high-value bioproducts by utilizing microbial cell factories – bacteria, yeast, filamentous fungi and algae. Microbial transformation of biomass is based on fermentation processes and can utilize a wide range of feedstock – agricultural and wood rest materials, food and aquaculture wastes, by-products and rest materials, industrial wastes such as glycerol from biodiesel production,

There are several examples of such biorefinery process which valorizing different rest materials and wastes:

- (i) production of omega-6 and omega-3 microbial oils by oleaginous microorganisms from lignocellulose and food waste materials;
- (ii) production of biopolymers such as chitin/chitosan and polyhydroxyalkanates (PHA) by filamentous fungi and bacteria, respectively;
- (iii) production of microbial biomass for animal and fish feed;
- (iv) recovery of phosphorus from aquaculture wastes;

Development of biorefinery production processes based on microbial cell factories includes an up-stream and down-stream process, where the up-stream is performed by screening through many microbial cell factories and substrates and development of fermentation process for the selected cell factory from micro-volumes to shake flasks and further to bioreactors. The down-stream process development is related to separation and extraction of final product components.

Both, up- and down-steam processes involving use of advanced vibrational spectroscopy techniques for analyzing chemical composition of microbial biomass, substrate consumption, product formation and efficiency of production separation during down-stream. The application of vibrational spectroscopy can be done both at-line and on-line and on different scales - from cell population → single cell → single organelles.

The BioSpec team at NMBU has an advanced vibrational spectroscopy laboratory equipped with Infrared and Raman spectrometers for at-line and on-line measurements. In addition, BioSpec has an automated robotic system coupled to Fourier transform infrared spectroscopy for high-throughput analysis.

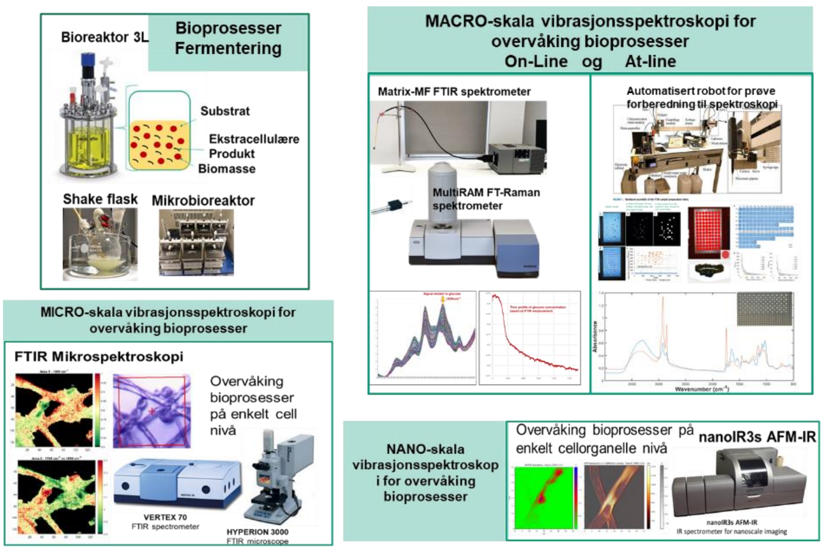


Fig. 1 The use of vibrational spectroscopy in a bioprocess.

**Examples of research tasks**

All research tasks related to the SRL project will be related to the development and monitoring of microbial fermentation and extraction processes by using IR and Raman at-line and on-line spectroscopy. All tasks will be connected to the on-going projects of the BioSpec team. The detailed description of on-going projects could be found here.

**Methods**

The research tasks will involve using both standard biology, chemistry and spectroscopy equipment:
**Biology equipment:** microtiter plate systems, shake flasks and bioreactors (3L), freeze drier.

**Chemistry equipment:** gas chromatography, supercritical fluid extractor.

**Spectroscopy equipment:** FTIR-HTS/ATR, FT-Raman, IR/Raman fiber optic probes, FTIR-FPA and Raman microscope.

**Literature**

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