There is a need for appropriate techniques that can monitor the growth of microbial communities in situ and the coupled biogeochemical and biogeophysical processes. Spectral Induced Polarization (SIP), a biogeophysical technique, can play a key role. However, the triggering mechanisms of SIP responses modulation by biogeochemical activity of microbial communities (biofilm) remain poorly understood. The overarching goal of this project is to find the correlations between biogeochemical processes occurring within subsurface microbial communities and spectral induced polarization (SIP) signatures in aqueous and/or porous media. Anticipated findings will allow for the interpretation of the geophysical responses associated with the development of microbial communities in field conditions.

We investigated the SIP response of biofilm components including cells, exopolysaccharides (EPS), cells in EPS and semi-conductive particulate matter such as magnetite in EPS. Using microbial cells from three different model organisms in liquid suspension and in porous media, we observed an increase in SIP parameters with increasing cell density with a very well defined relaxation peak at a frequency of ~10 Hz which was predicted by recently developed quantitative models. However this characteristic relaxation peak was minimized in the presence of porous media. We also observed that cells suspended in EPS enhances the polarization and also shows a peak frequency at ~10 Hz.

The study of alginate gelation (representing EPS) in liquid phase and porous media in vitro revealed that solidified (gelated) alginate isolated from brown algae increased the magnitude of imaginary conductivity while real conductivity increased very moderately. In contrast, the study of the SIP response within a porous medium filled with solidified gel of alginate isolated from mucoid strain P. aeruginosa FRD-1 showed an increase in the magnitude of both imaginary and real conductivities. Further, the addition of magnetite particulates in the EPS enhanced the gelation process and the magnitude of the SIP response.

We also continued with the development of our quantitative model to investigate frequency-domain induced polarization response of suspensions of bacteria and bacteria growth in porous media. Our model results show that the growth rate and endogenous decay coefficients of bacteria in porous sand can be inferred non-intrusively from time-lapse frequency-domain induced polarization data.

Conclusions: 1) the time-lapse SIP data are applicable for the evaluation of growth rate and endogenous decay of bacteria in porous media. This finding helps to enhance the interpretation of SIP measurements from field sites; 2) SIP parameters are sensitive to the transition of an alginate from liquid to solidified stage; 3) the magnitude of SIP signatures reflects both cell density, biofilm maturity and the presence of secondary minerals; and 4) bacteria may have a characteristic low frequency relaxation peak at 10 Hz.
Our next goals include but not limited to the study of the modulation of SIP responses by field-relevant organisms *Geobacter sulfurreducens* along with its ΔpilA mutant, and *Disulfovibrio vulgaris*. Anticipated results will be useful for the development of a mechanistic model for the induced polarization response.