High speed assessment of AMD (acid mine drainage) on germination radish seeds using biospeckle optical coherence tomography

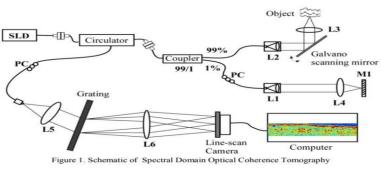
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1. Introduction

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Acid mine drainage (AMD) is a sulfuric discharge containing metals and particulates that can spread to nearby water sources, imposing toxicity and physical stress to living things. AMD is formed due to the oxidation of iron pyrite and other sulfidic minerals exposed to water and oxygen due to mining operations. Under these conditions, the minerals release Fe, SO₄²⁻ and H^{+[2]}. Optical Coherence Tomography is a non-contact and non-invasive optical imaging technique that acquires tomographic images of samples. It was demonstrated that the biological activities of plant samples can be evaluated by bOCT in our previousstudy where we proposed to use biological signal obtained in OCT for the plant under O_3 stress using biospeckle OCT (bOCT)^[1]. In this study, the influence of the AMD on seed germination was monitored, using bOCT under different AMD concentrations.



2. Experiments and results

In contrast to conventional OCT, bOCT permits nondestructive and noncontacting evaluation of biological activities of seed at early stage. Figure.1 shows the experimental system of bOCT. A Spectral Domain OCT (SD-OCT) system was set up in this work to achieve high resolution OCT imaging. .

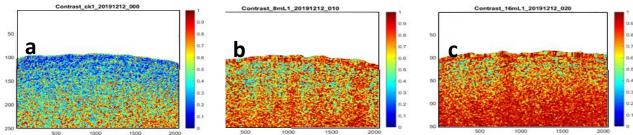


Figure 2. Speckle contrast images of radish seeds under AMD of different concentration a (control), b (149mmol/L), c (298mmol/L) at 48hs after exposure.

In the experiments, radish seeds was exposed to AMD solution of different concentrations of 0,149, and 298 μ mol/L for 3days. Asnamic laser speckleor biospeckle is produced due to the movement of the scatters and organelles in the tissue. The degree of the variation of biospeckle reflects a biological activities of the tissue. Here we introduce biospeckle contrast to evaluate the biological of activities of section.

The field of the fissue. Here we introduce biospeckie contrast to evaluate the biological activities of sample. $C_b = \sigma_1/\langle I \rangle$ Where σ_1 and $\langle I \rangle$ are standard deviation and mean biospeckle signal along temporary axis. Figure 2 shows biospeckle contrast images observed at 48h AMD exposure. From Figure 2 we can see that the radish seeds are more active under AMD treatment, which means that AMD can promote seed germination. This may be due to the influence of Fe³⁺ concentration and pH on seed germination. This coinsides the fact that the germination time for control was 3days and 2 days for AMD treated ones.

3. Conclusion

AMD of experimental concentrations promote the seed germination. The study employs OCT biospeckle signal to directly monitor the effects of AMD on seeds of radish, and bOCT has demonstrated that the influence of AMD on the development of seed can be monitored within only a few hours of exposure. We presented an optical method that can be used for in-vivo studies of plants under environmental stresses.

References

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[2] Roychowdhury, Abhishek, D. Sarkar, and R. Datta. "Remediation of Acid Mine Drainage-Impacted Water." Current Pollution Reports 1.3(2015):131-141