**An Overview of Wide-field Raman Imaging and Its Applications**

**List of Abbreviations**

• Wide-field Raman imagine => Wide-field Raman imaging

• SEM Scanning Electron Microscope

• RS Raman Spectroscopy => delete

• IR Infrared Imaging

• QA/QC Quality Assurance / Quality Control

**Abstract**

• Wide-field Raman imaging is a technique that combines Raman spectroscopy and imaging techniques. It provides spatial distribution for one or a few specified chemical components in a sample. => Wide-field Raman Imaging (WRI) is a powerful technique for generating detailed chemical images. It combines Raman Spectroscopy (RS) and Raman imaging techniques together and can provide the spatial distribution information for one or a few specified chemical components in the sample.

• Features like molecular specific, non-destructive, non-labeling, and capability of analyzing wet samples make WRI a prospective alternative method to fluorescence, IR imaging, and even SEM. => Features like molecular specificity, non-destructive and non-labeling testing, and the capability of analyzing wet samples make WRI a prospective alternative method to fluorescence imaging, IR imaging, and SEM in some application field.

• The recent advancements in the instrumental setup facilitated applications in many areas of knowledge; the raising applications and market demands, in turn, push the development of instrumentations. => Recent advancements in WRI instrumental setup facilitated the application in many areas; the raising applications and market demands, in turn, pushed the development of instrumentations.

• This study provides an overview of WRI with a special focus on recent advances. => In this context, this study provides an overview of WRI with a special focus on recent advances.

• The theoretical background of Raman effect and several forms of Raman spectroscopy, such as Surface-enhanced Raman spectroscopy, Resonance Raman spectroscopy, and Coherent anti-Stoke Raman spectroscopy are provided in Chapter 2. => Firstly, the theoretical background of Raman effect and several forms of Raman spectroscopy, such as SERS (Surface-Enhanced Raman Spectroscopy), Resonance Raman Spectroscopy (RRS), and Coherent anti-Stoke Raman Spectroscopy (CARS) are provided in Chapter 2.

• Raman wide-field imaging and its instrumental setup are introduced in Chapter 3. => Raman wide-field imaging and its instrumental setup are then introduced in Chapter 3.

• Further, Chapter 4 describes the applications in significant areas, including material analysis, biology, biomedicine, pharmaceutical, food, threat detection, and forensic science. => Furthermore, Chapter 4 describes the application of WRI in some presentative areas, including material analysis, biology, biomedicine, pharmaceutical, food, threat detection, and forensic science.

**Introduction**

• Wide-field Raman imaging (WRI), a subtype of Raman imaging, captures the sample images based on their Raman scattering. It detects the presence of specified chemical components and features their locations in the samples simultaneously. => Wide-field Raman imaging (WRI) is a type of Raman imaging technology that captures the image of a sample by Raman scattering. It detects the presence of specified chemical components and features their locations in the samples simultaneously.

• A tunable filter, a laser with fixed wavelength, and a microscope were used to visualize the chemical crystals in this experiment. => In this experiment, a tunable filter, a laser with fixed wavelength, and a microscope were used to visualize the chemical crystals.

• During the past few decades, the developments of laser, filters, and data processing algorithms have fuelled numerous studies on the instrumentations and applications of WRI. => lasers?

• WRI has many promising features thanks to the properties of Raman scattering, such as non-destructive, molecular specific, simple sample preparations, and capability of analyzing wet samples. => WRI has many promising features thanks to the properties of Raman scattering, such as non-destructive testing, molecular specificity, simple sample preparation, and the capability of analyzing wet samples.

• It also shows unique characteristics among Raman imaging techniques. => ~~It also shows unique characteristics among Raman imaging techniques.~~

• Point mapping, line scanning, and wild-field imaging are the three major types of Raman imaging. => In general, there are three types of Raman imaging: Point mapping, line scanning, and wild-field imaging.

• Although wide-field Raman imaging shows great opportunities in numerous applications field, there are few published reviews on its instrumentations and application so far (accessed on ninth of May 2020). => 1) Although WRI shows great opportunities in above applications field... 2) add to the previous paragraph. 3) accessed ？

• So is its instrumentation. => The same situation comes to their instrumentation.

• This literature review is an introduction to wide-field Raman imaging => This literature review is an introduction to WRI

• The fundamental principles of Raman effect and Raman techniques => connect the previous paragraph

• The application fields... => The application fields highlighted in Chapter 4 are material characterization, biomedical, pharmaceutical, threat detection, and food safety. Moreover, the advantages and limitations are discussed, some other areas are also briefly reviewed. The typical applications, as well as their instrumental setup, are summarized in the Appendix due to the page limitation.

• Finally, we conclude this paper with the discussion of WRI instruments and applications in Chapter 5.

**Conclusion**

• This study provides an overview of the instrumentation and applications of WRI. => This study provides an overview of the instrumentations and applications of WRI.

• It may limit the system to image only one or few Raman wavelength => It may limit the system to image only one or few Raman wavelengths

• Applications in the past two decades are reviewed in Chapter 4 and summarized in the tableA1- tableA5 in the Appendix. => Applications of WRI are reviewed in Chapter 4 and summarized in the tableA1- tableA5 in the Appendix.

• In the reviewed studies, materials and pharmaceutical, and food samples are usually examined or visualized by the characteristic Raman wavelength of a specified component in the samples. => In the reviewed studies, material, pharmaceutical, and food samples are usually examined or visualized by the characteristic Raman wavelength of a specified component in the samples.

• In those fields, WRI shows the potential to be used as a routine analysis for QA/QC, for example, detecting material defects, monitoring material synthesis, screening for containments and additives. => In those fields, WRI shows the potential to be used as a routine analysis for QA/QC. For example, detecting material defects, monitoring material synthesis, and screening for containments and additives.

• Cells, one-celled organisms, and tissues, including bones, are widely studies. => Cells, unicellular organisms, and tissues including bones have been extensively studied.

• It should be highlighted that WRI is extremely useful for living cell imaging for its short acquisition time. => It should be highlighted that WRI is extremely useful to living cell imaging for its short acquisition time.

• The feasibility studies of tissue classifications and lesion detection in bones have demonstrated that WRI could be used to assist clinical diagnosis in the foreseen future. => The feasibility studies of tissue classifications and lesion detection in bones have demonstrated that WRI could be leveraged to assist clinical diagnosis in the foreseen future.

• Detection of explosives is discussed in threat detection. Different from other applications, a telescope is used in such studies to allow stand-off detection. => WRI can also be a useful tool to detect the explosives. Different from other applications, a telescope is used in such studies to allow stand-off detection. // connect to the previous paragraph.

• Although it has been proven to be a powerful tool for application in various fields, WRI is limited by the common problems that share among any Raman techniques and the drawbacks produced by the global illumination. => Although WRI has been proven to be a powerful tool for application in various fields, it is limited by the common problems among Raman techniques and the drawbacks produced by the global illumination.

• the two significant problems undermines the analytical strength of any Raman techniques. => the two significant problems undermines the analytical strength of ~~any~~ Raman techniques.

• The photon migration effect and the lack of depth resolution are the two major problems brought up by the global illumination. => Whereas the photon migration effect and the lack of depth resolution are the two major problems brought up by the global illumination.

• The increasing number of applications using SE(R)RS => Besides, the increasing number of applications using SE(R)RS

**ToDo list**

• Check all the abbreviations again