Utilisation of FTIR Imaging for Study of Human Breast Calcifications

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The accurate and safe detection and diagnosis of breast cancer is a significant issue in the UK, with annual incidence of around 46,000 women and 300 men [CRUK 2011]. Early diagnosis of the disease allows more conservative treatments and better patient outcomes. Mammographic screening has demonstrated itself to be effective at identifying lesions within older women. However, the identification of a suspect lesion does not provide the clinician with its benign or (pre-)malignant status. Therefore the removal of tissue for histopathological staining is necessary to make this diagnosis. In 2008/9, 2.1 million women were screened in the UK. Approximately 4.4% of women screened were referred for further assessment and only 0.8% of those women screened were found to have malignancies. [www.cancerscreening.nhs.uk] This demonstrates that 74,860 women in 2008/9 had further investigations including excisional biopsy, posing risks and anxiety to the patient, and significant costs to the NHS.

Breast calcifications although used as an indicator for disease in mammography (even though the vast majority of women have calcifications when they get older) have largely been ignored as diagnostic markers. Here using FTIR spectral imaging we demonstrate that breast calcifications have a composition directly related to the surrounding breast pathology. Secondly, we explore the heterogeneity of calcification compositions and the interface between the calcifications and the tissue using benchtop and synchrotron (Diamond, UK, Soleil, France and Aladdin, Wisconsin, USA) based spectrometers. Further studies have involved exploration of ATR imaging to enhance our spatial resolution. Pros and cons of these techniques and results are discussed.

A selection of multivariate techniques have been employed to provide a measure of compositional variation across the hyperspectral images. Results show that there is a progression seen in the calcification composition, with decreasing carbonate concentration in the outer zones of the calcifications. This leads to a hypothesis that the carbonate substitution of the calcium hydroxyapatite is more readily dissolved in malignant tissues due to the surrounding tissue exhibiting a lower pH. This is believed to increase the carbonate solubility.