BIOMEDICAL APPLICATIONS BASED ON A COMPARATIVE RAMAN AND CARS-IMAGING STUDY

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Raman (micro-)spectroscopy has been recognized to be a powerful tool to study cells and tissues because the method provides molecular information without external markers such as stains or radioactive labels. To overcome the disadvantage of low signal intensities from most biomolecules, strategies to enhance the Raman signal are utilized. A nonlinear variant of Raman spectroscopy called coherent anti-Stokes Raman spectroscopy (CARS) belongs to the most promising techniques because it combines signal enhancement due to the coherent nature of the process with further advantages such as directional emission, narrow spectral bandwidth and the absence of autofluorescence background.

Our work focuses on the systematic experimental evaluation of the information content, which can be obtained from using the complementary strengths of Raman and CARS micro-spectroscopy. Raman images were analyzed by chemical mapping representing a univariate algorithm and by k-means clustering representing a multivariate algorithm. Whereas variances within tissue sections could be visualized in chemical maps of CARS and Raman images, identification of tissue types and characterization of variances between different tissue sections was only possible in cluster mean spectra. A representative comparison of the information content of various approaches is presented in the figure 1 and illustrates the potential of applying vibrational micro-spectroscopy in biomedical tissue diagnostics.

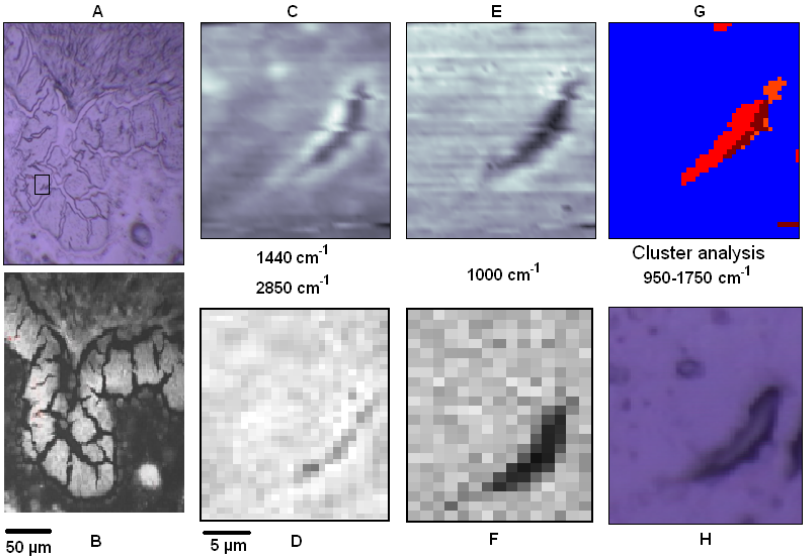

Figure 1: Photomicrographs (A, H), CARS images (B, D, F) and Raman images (C, E, G) of a villus. CARS images were recorded at 2850 cm^{-1} (B, D) and at 1000 cm^{-1}. Raman images display the integrated band intensity at 1440 cm^{-1} (C), at 1000 cm^{-1} (E) and the membership map of a cluster analysis in the interval 950-1750 cm^{-1}.