Fibre-based probe for Brillouin Imaging – Progress and Challenges

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The modality of Brillouin imaging(BI) has opened up the possibilty of the extraction of viscoelastic properties of tissues and cells with micron-level resolution in a label-free, non-contact and non-invasive way. So far, the conventional bulk-optics based Brillouin system has already been applied to cells [1], artery walls [2] and human corneas [3]. It comes as no surprise then that the application of BI in real-time in vivo imaging, i.e. a Brillouin endoscope, is seen to have much potential as a diagnosis tool in clinics. There are however design challenges of an endoscope that are more stringent due to the spatial and somatic restrictions of the living samples. Therefore, the optimisation and miniaturisation of the existing technology into a flexible, fibre-based endoscopic device remains the research goal here.

One of the main challenges for creating a fibre-based Brillouin system is that the fibre itself will contribute to the scattering. This is likely to clash with the useful signal from biological samples and it is significantly stronger in signal strength due to the much greater scattering volume available in the fibre. Hence finding a solution to minimise fibre scattering is key to constructing the Brillouin Endoscope. One simple solution would be the separation of the illumination and collection path, as it should eliminate the parasitic signal coming from the fibre conduit due to the geometric condition required for Brillouin scattering. A proof-of-concept set-up is illustrated and the measurements of Brillouin shifts in various typical bio-liquids have been obtained and compared to reported values. This is to our knowledge the first time that these values have been obtained using an all-fibre device [4].

On the other hand, to retain a maximum collection efficiency, a single-path set-up maybe more desirable. In this case, a proximal-side interferometric filter [5] can be used to suppress the undesirable fibre Brillouin and elastically scattered signals at the same time with the appropriate Free Spectral Range. Additionally, the SNR of the system may be further enhanced with software-based reconstruction techniques [6]. These methods are more attractive for their wider applicability and have been found to be capable of extracting useful information with SNR as low as 1 in simulation and experiment.

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