POLARIZATION AND SECOND HARMONIC GENERATION MICROSCOPY

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Second harmonic generation microscopy (SHGM)[1] is rapidly becoming a popular technique in biomedical imaging. An important feature of SHGM is that the radiation generated travels preferentially in the forward direction, depending on the geometry of the sample, so that SHGM in transmission is conveniently combined with TPFM in epi-illumination. SHGM is sensitive to the polarization of the illumination. In most cases the effects of the focused beam have been approximated by an effectively scalar theory [2], or one that concentrates on the dominant component of the illuminating field [3]. A full, vectorial theory has been given by Asatryan *et al.* [4].

Radially polarized beams when focused tightly exhibit a small focused spot and strong axial field component [5-8]. They have been used to generate second harmonics from surfaces [9]. The field at the focus is directed along the axis. Near to the focus there is a weaker radial field component. This contrasts with a focused plane-polarized beam, which exhibits a strong transverse field component, a weaker axial field, and an even weaker cross-component.

According to the non-zero values of the $\chi^{(2)}$ tensor, components of polarization can be generated parallel or perpendicular to the dominant illuminating field component, which then radiates as an electric dipole. Either plane polarization or radial polarization can result in transverse or longitudinal dipole components. The second harmonic generated by linear objects, such as collagen fibres, has been investigated, based on the field of a complex source/sink combination [6]. The phase in the focal region can produce an annular beam from an extended object as a result of phase-matching [2]. We find that the component generated from $\mathbf{E}_x\mathbf{E}_z$ (plane-polarized) or $\mathbf{E}_z\mathbf{E}_\rho$ (radial polarization) can be appreciable.

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