ACOUSTICS2008/2869
Noninvasive Monitoring of Mesenchymal Stem Cells by 1.2 GHz Acoustic Microscopy

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Cell-based therapies can benefit from non-invasive and marker-free monitoring techniques for living cells. For this purpose a phase-sensitive scanning acoustic microscope operating at a frequency of 1.2 GHz was combined with a commercial confocal laser scanning microscope. The system is equipped with a live-support system for the long-term observation of living cells. Confocal acoustic imaging with phase and magnitude contrast and confocal laser scanning microscopy can be performed simultaneously. Both techniques are used in reflection from opposing sides of the object. Time-lapsed acoustic microscope images of ovine mesenchymal stem cells are presented. For this purpose, a pseudo-3d representation is generated by encoding the unwrapped phase in the height and the magnitude in the brightness.
In the case of highly reflective substrates and sufficiently low reflection from the interface between the cells and the surrounding fluid the echo from the top of the cells can be neglected and the phase contrast image can be transformed to a time-of-flight image. In the same approximation the magnitude image provides information about the gradual extinction of the echo signal due to absorption in the cells. The two images can be combined to generate a new form of contrast representing the product of the absorption coefficient and the velocity of sound inside the observed cells.