Multiphysics Simulation of a High Frequency Acoustic Microscope Lens

O. Tommiska[1], J. Mäkinen[1], J. Hyvönen[1], A. Meriläinen[1], A. Salmi[1], E. Hæggström[1]

[1]Department of Physics, Division of Materials Physics, University of Helsinki, Helsinki, Finland

Abstract

High frequency ultrasound (100-1000 MHz) has been used in microscopy since the 1970s. The main imaging component, the acoustic lens, is commercially available. The resolution, working distance, and focal length depend on the structure of a lens, which is unique for each produced lens. Hence when using a broadband signal, the focus distance may vary over the frequency band. If this is the case, knowing how the different frequencies focus, one can use this information to enhance the imaging resolution by taking into account the shift of focus for the different frequency components. We created a COMSOL Multiphysics® model of our scanning acoustic microscope (SAM) to study this effect. To have the exact geometry of the outer surface of a commercial lens, we imaged one with a scanning white light interferometric 3D microscope and used this geometry in the simulations.

To simulate the action of the SAM, Acoustic-Structure interaction was used to model the coupling between the acoustic lens and water. Solid Mechanics interface was used for the lens and Pressure Acoustics interface for water. Both frequency domain and time domain simulations were done. The frequency domain was used to sweep through the frequency range of interest and the time domain to compare pulsed signals to the predictions obtained from the frequency domain simulations.

The results show the shape of the focus as a function of frequency, both for narrowband and broadband excitation. The results are then used to optimize the imaging resolution of our SAM.

Figures used in the abstract

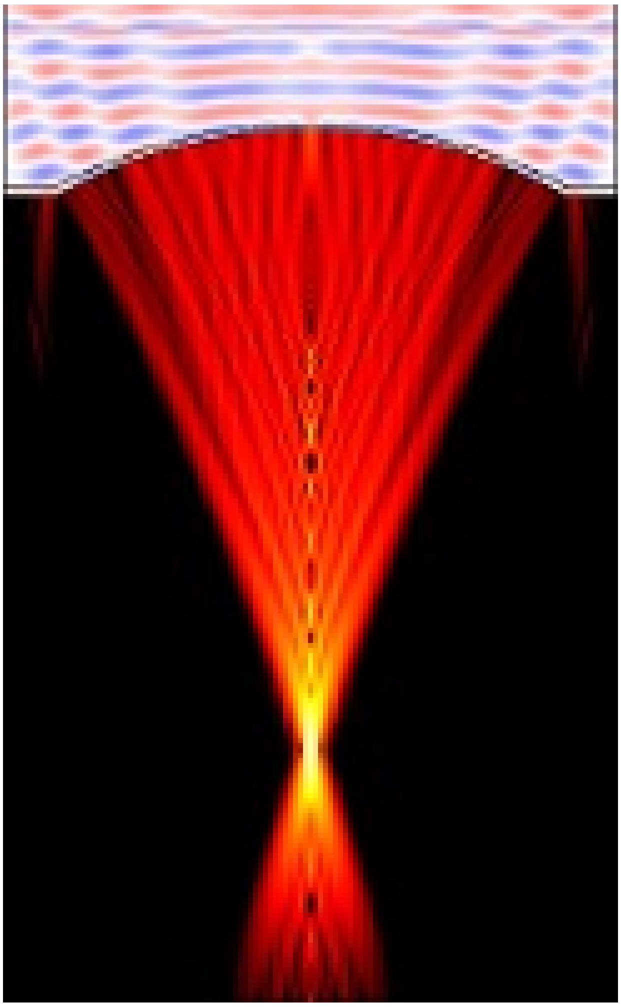

Figure 1: Pressure field inside the solid acoustic lens and the focused intensity field in water.