A homodyne scanning laser interferometer has been developed for detailed imaging of vibration fields on microacoustic components, with frequencies ranging from several kHz up to 2.5 GHz [1]. The setup detects the relative out-of-plane vibrations with a lateral resolution of better than 1 µm and with minimum detectable amplitudes of the order of 1 pm. We have recently implemented a new detection scheme for more complete characterization of surface acoustic wave, bulk acoustic wave, and micromechanical devices. This method enables phase sensitive detection of the vibration fields without active stabilization of the interferometer to the operation point. The concept allows for a simple interferometer design without any feedback loops. Furthermore, it also enables absolute amplitude measurements via a simple calibration procedure.

Traditionally, contrary to the new concept presented here, homodyne interferometers have been stabilized to one of the quadrature points (QP, a.k.a. operation point) to enable phase and absolute amplitude measurements [2]. Without stabilization, the interference signal drifts randomly between several QPs, typically due to environmental changes, thus leading to ambiguity in determining the phase of the surface vibration.

To overcome this phase ambiguity problem, our detection scheme utilizes a linear ramp sweep of the optical path length through several QPs. During the sweep, both the high-frequency signal due to surface vibrations and the low-frequency signal due to the optical path sweep are simultaneously measured from the interference signal. The low-frequency signal can then be utilized to determine the phase and the absolute amplitude from the high-frequency signal.

We present a detection scheme allowing for phase sensitive absolute amplitude measurements of surface vibrations without a need for stabilizing the interferometer. To further illustrate the performance obtained, we present both amplitude and phase measurements of the vibration fields in a piezo-actuated micromechanical square-plate resonator [3] with a main resonance frequency of 26.4 MHz.

[3] Resonator is designed and fabricated at VTT.