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A high performance I/Q-interferometer using a polarizing beam displace and its application to resolution refractive index sensor

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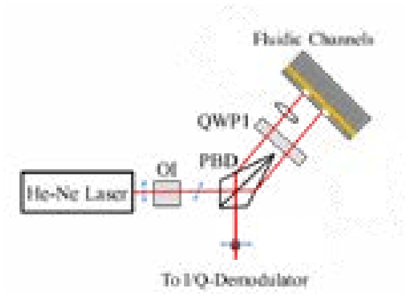
It has been shown that an I/Q-interferometer can be used for measuring refractive index of a liquid or liquid mixture flowing through fluidic channels. We recently developed a new I/Q-interferometer which may be ideal for fluidic channel measurements because of its simple optical arrangement and capability of adjusting beam separation. A schematic of optical arrangement is shown in the image. The polarizing beam displace (PBD) is a modified polarizing beam splitter for which the two output faces are angle polished to make two orthogonally polarized output beams from the polarizing beam splitter parallel to each other. The output beams are circularly polarized with opposite handedness are making double pass through the corresponding liquids in the fluidic channels by use of the mirror coated on the backside of the fluidic channel. The phase difference and amplitude difference between the returning two beams are induced by the corresponding liquids in the fluidic channels. After making double pass in the quarter-wave plate, the plane of polarization of the two beams are rotated by 90^{o} and combined at the PBD. The combined beam is output through the remaining port of the PBD and sent to the I/Q-demodulator. The phase difference and amplitude difference are measured simultaneously by using either a homodyne or a heterodyne I/Q-demodulator. We had shown that a heterodyne I/Q-interferometer with more complicated optical arrangement can measure 1x10^{-8} refractive index difference between liquids in the reference and probe channel. Our new arrangement can provide a better sensitivity because not only it has a fewer number of optical components but also the system can be integrated into a small size device. In the sample channel, reference fluid and sample fluids can be flown through an alternating way. Phase measurements across consecutive liquid flow and unwrapping measured phases allow a precision measurement of refractive index difference between two liquids.



Recent Publications

1. Eang S H and Cho K (2017) Balanced-path homodyne I/Q-interferometer scheme with very simple optical arrangement using a polarization beam displacer. Optics Express 25:8237-8244.
2. Park J G and Cho K (2016) High-precision tilt sensor using a folded Mach-Zehnder geometry in-phase and quadrature interferometer. Applied Optics 55:2155-2159.
3. Rzasa J R, Cho K and Davis C C (2015) Long-range vibration detection system using heterodyne interferometry. Applied Optics 54(20):6230-6236.
4. Eang S H, Yoon S, Park J G and Cho K (2015) Scanning balanced-path homodyne I/Q-interferometer scheme and its applications. Optics Letters 40:2457-2460.
5. Yoon S, Park Y K and Cho K (2013) A new balanced-path heterodyne I/Q-interferometer scheme for low environmental noise, high sensitivity phase measurements for both reflection and transmission geometry. Optics Express 21:20722-20729.

Biography

Kyuman Cho has expertise in precision measurements using various interferometer schemes. He has been performing extensive researches in developing interferometric approaches in many high sensitivity applications sensors such as a scanning microscopy for characterization of optical properties of surfaces and materials, readout sensor for reaction monitoring on a biochip, long range vibrometer, and many other applications. He has been also working on diagnostics of the magnetically confined plasma in KSTAR, the fusion reactor project in South Korea. He has been a Professor of Physics, Sogang University since 1992. He has been a Visiting Professor in the Department of Electrical and Computer Engineering, University of Maryland, USA, Institute of Cosmic Ray and Radiation, University of Tokyo, Japan. He is a Collaborator for KAGRA, a cryogenic gravitational wave antenna, being built in Kamioka, Japan.

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