

# Observation of ultrasound using coaxial interferometer for control of femtosecond laser drilling

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The laser drilling of micro holes is used for plastics to make electric conductivity between both surfaces of printed circuit boards, for thin glasses and plastics to increase the density of circuits in integrated semiconductor circuits, and for stainless steel tubes such as nozzles and injection needles in medical devices. The hole drilling is always required high density, high precision, and mass production in the industry. Femtosecond laser processing is suitable for the micro laser drilling, because it has no thermal effect.

The optimal laser parameters are determined through prior experiments and the accumulated results depending on the type and shape of the workpiece. An in-process measurement and the real-time feedback control of the laser parameters will reduce the amount of the prior experiments. The in-process measurement is performed with an ultrasound measurement. The use of the ultrasound has the advantages for optical measurements: non-contact and deep part for opaque material. The observation of the ultrasound generated by a femtosecond laser pulse irradiation to a material and the use of the observed signals for an in-process control of laser parameter in the femtosecond laser drilling. The sounds generated during femtosecond laser processing has wide frequency range. The sound with the range up to several hundreds of kilohertz can be observed with a microphone and the signal will be use for the control of laser parameter, because the magnitude of the sound has a monotonical relation of the amount of laser ablation. According to Webster's Horn equation, the sound with higher frequency should be measured to know the depth of the processed hole from the generated sound. In this study, an optical microphone implemented with a coaxial interferometer is used to detect the high-frequency sound. The coaxial interferometer is adopted from its external vibration resistance.

## Short biography:



Kaede Yamauchi was born in Kanagawa in April 2001. she graduated from Atsugi High School in March 2020. She entered Utsunomiya University, Faculty of Engineering in April 2020. She currently he is a student in Utsunomiya University, Center for Optical Research & Education (CORE). He is a fellow member of SPIE. Recently, she is focused to Laser processing using sound measurement.