

# Characterization of High-Speed Varifocal Tunable Acoustic Gradient Index of Refraction Lens

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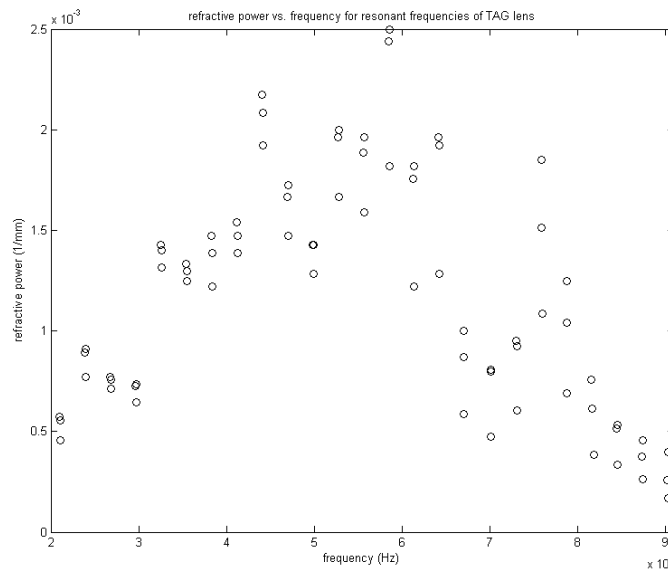
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Traditional varifocal optical elements such as spatial light modulators (SLMs) allow for precise optical manipulation while being limited by slow switching speeds of around 100Hz. A tunable acoustic gradient index of refraction lens (TAG lens) allows for comparably precise manipulation at switching speeds of around 20kHz making it a valuable instrument for high-speed, precision optical manipulation.

Such fast switching speeds are the result of a piezoelectric transducer within the TAG lens that forms acoustic waves in a fluid creating continuous density and index of refraction variations. When the piezoelectric is driven with a constant frequency-modulated signal, arbitrary Bessel patterns can be created in an incident Gaussian beam. Only certain resonant frequencies will create a Bessel pattern ranging from 230kHz to 1MHz with an average step size of approximately 29kHz.

As the TAG lens becomes used more widely for manipulation and machining it is necessary to characterize the temporal as well as behavioral parameters of the lens at different resonant frequencies. Of the temporal parameters, transition time between two vibration states at a constant frequency and between two frequencies along with switch-on time were of interest.



Preliminary behavioral analysis of lens response at different resonant frequencies shows that some frequencies have a greater refractive power which is defined as the inverse of the measured radius of curvature. For application purposes, this information is crucial for choosing a resonant frequency suited for the application. Analysis of the temporal parameters will further characterize the capabilities of the TAG lens and allow for the lens to be used in novel and varied applications where high-speed switching is necessary.

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