Increasing Scanning Range of Mems Mirrors for Endoscopic Optical Systems via Submersion in High Ri Fluids

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MEMS (microelectromechanical systems) scanning mirrors are used extensively in laser scanning microscopy and medical endoscopic optical systems as a result of their small size, low per-unit cost, and efficient power consumption. However, due to the fragility of MEMS actuator systems, their scanning range is often severely compromised, reducing their efficacy in imaging applications. Using the Snell's window phenomenon, this issue can be rectified by submerging the mirror into a fluid with a high RI (refractive index). In order to test the effectiveness of these submersion fluids, a copper/tungsten bimorph MEMS mirror, whose central plate measured 550*550 μm, was submerged in ethyl cinnamate, mineral oil, and silicone oil (with refractive indices of 1.56, 1.45, and 1.39 respectively) and an increase in the mirror's maximum output angle was observed. Further optical tests revealed that the submersion fluids distorted the laser beam, changing the laser spot both in size and in shape. Additionally, as a result of the fluids' high viscosity and dampening effects, the submerged MEMS mirror could not perform resonant scanning, and its maximum actuation frequency was limited to 100 Hz. Further experimentation to solve the distortion and response time issues in submerged MEMS mirror systems will be required; alternative high RI submersion fluids also need to be tested. Nevertheless, this submersion technique has the potential to be a very successful yet simple way of producing a wide-angle scanning device, which could open greater opportunities in optical systems using MEMS mirrors.