IMPROVING THE PERFORMANCE OF THE OPTICAL MICROSCOPE VIA MODERN OPTO AND OPTOMECHANICAL DESIGN

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The trend in biological applications of optical microscopy has been towards greater precision and more quantitative experiments, requiring greater stability from the microscope. Furthermore, in many instances improvements in the interpretation of experiments are possible if data from several complementary methods are acquired simultaneously, requiring more flexibility in the configuration of the microscope. We are systematically improving the microscope through an integrated optical and the mechanical design. Our goals are to increase the resolution and sensitivity of experiments by improving rejection of external mechanical disturbances and minimizing of drifting of the microscope itself, especially due to thermal fluctuations. In addition, to make assembly of complicated experiments more convenient, we have developed self-aligned optical modules connected via kinematic couplers which allow rapid reconfiguration of the microscope with better than 300 nm repeatability [1].

Inhomogeneous thermal expansion of the body of the microscope is a major cause of instability during experiments. However, the optical train of the infinity-corrected microscope is not sensitive to motion in all directions. By using symmetry, the expansion of the mechanical structure can be channeled into directions which do not effect the optical measurement. We have both modeled and tested by experiment the expansion of cylindrical structures and found that symmetry and shielding can reduce thermal drift sufficiently without the need to resort to low thermal expansion alloys [2].

We have also developed novel flexure stages with millimeter travel ranges for sample positioning and focusing [3]. The longer range of these stages allow a single stage to be used for both coarse and nanometer positioning while retaining the advantages of flexure stages.

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