



Improved Metrology and Stage For Advanced Lithography Project Summary

OPTRA has proposed, developed, built and successfully demonstrated an Improved XY Metrology System with 0.3nm resolution, repeatability at the 20nm level and a maximum measurement speed of 700 mm/sec. OPTRA has also developed a high performance hybrid mechanical stage and controller system that utilizes the improved metrology system, a dual axis planar encoder, as the feedback metrology. The planar encoder uses a focused laser diode to illuminate a dual axis grating, or grid. The grid reflects multiple order beams back into an optical system that spatially selects and recombines the 2 first order beams onto a proprietary tri-phase detector array. The measurement is made interferometrically in such a way that there are two cycles of electrical phase change for a displacement equal to one grating spacing. The encoder sensor head and associative data processing electronics are designed to resolve 14 bits per electrical cycle, or phase modulo 2π , resulting in a 0.3 least significant bit of a 32 bit two's complement digital word. Two planar encoder sensor heads have been produced during the Phase II study. The planar encoder sensor heads have been calibrated versus a Hewlett Packard two-frequency plane mirror interferometer resolvable to 5 nanometers. The planar encoder sensor heads demonstrate an accuracy of approximately $\pm 10\text{nm}$. The maximum work area of the metrology system is defined by the 125mm x 125mm grid dimensions.

The hybrid mechanical stage combines a six-degree-of-freedom fine tune flexural stage integrated into a large coarse DC motor propelled airbearing stage. The control system performs nested PID filters on the feedback error signals. Motion is commanded and controlled with a Motion Engineering programmable DSP-based multiaxis controller board. Closed loop controlled moves have demonstrated a $\pm 30\text{nm}$ repeatability in under 200 millisecond settling time. The hybrid mechanical stage and servo control design demonstrated good to fair results in the Phase II effort. However, OPTRA plans to continue optimizing stage performance to the capacity of the metrology design.