APPLICATION NOTE

IMPROVING REPEATABILITY IN MASK REGISTRATION ALIGNMENT

The Problem

The transistors, diodes, resistors, capacitors, and connectors which make up integrated circuits are increasing in number and decreasing in size. Thus, the mask maker is faced with tightening registration specifications without a similar increase in the capabilities of mask measurement equipment. Faced with this problem, Intel Corporation worked with Nikon Precision Inc. (NPI) on a project to determine whether or not XY-2I (an NPI mask comparator/dimensional measurement system) performance could be improved. The largest sources of error were:

1. Air temperature measurement error (including NPI temperature probe placement);
2. Temperature differences between the X and Y paths of the stage interferometer laser;
3. Plate temperature measurement error (NPI temperature probe) including equilibration/climatization, plate temperature uniformity, and NPI temperature probe placement problems;
4. Uncontrolled/non-optimized airflow in the environmental chamber.

Items 1 through 3 all affect the compensation applied to the interferometer laser. If the offsets between the X and Y paths are constant, system software can compensate for these offsets. However, these offsets were a function of time (prior to modification) and the system software cannot compensate for this, resulting in random measurement errors. Likewise, not allowing the plate to equilibrate can produce non-compensatable offset errors. Item 4 produces the same errors seen in Item 1 through 3 because poor airflow allows the formation of temperature gradients across the machine and the plate.

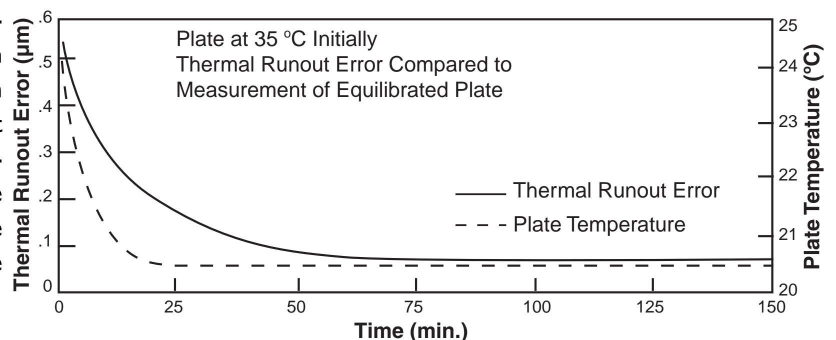
The Solution

The operating temperatures of the machine and an equilibrated plate were examined using Luxtron Fluoroptic® probes. The temperature measurement errors were quantified and shown to vary randomly with time. Intel then modified the environmental chamber airflow conditions using air diverting curtains and fans. The Luxtron probes were used to monitor the temperature of the machine and plate until the curtain and fan positions were optimized. When the optimum configuration was achieved, there were no X vs. Y temperature gradients.

The Luxtron surface temperature probes were then used to measure actual air temperature and plate temperature. The NPI temperature probes were then moved around the machine until a position for them was found that reduced or eliminated the temperature offset and the time lag between changes in the actual temperatures and the NPI temperature probe response.

Also the use of the Luxtron surface temperature probes allowed the determination of the plate temperature distribution. Intel monitored the plate temperature distribution to equilibrium and discovered that it took 75 minutes for the plate to show no more thermal effects on mask measurements, even though the plate temperatures had equilibrated in about 30 minutes.

These changes have increased the repeatability to 3s ≤0.05mm over 100 mm as compared to an initial value of 3s ≤ 0.15mm over 100mm, based on 75 operating days of data. An added benefit of this increased repeatability is that the test machine can now be more easily matched with another XY-2I modified in the same manner.



Thermal Runout Error and Plate Temperature vs. Time.

Reference

S. Lyle, R. Rodriguez, P.M. Troccolo, "Improving Nikon XY-2I Performance," presented at The Sixth Annual Technical Symposium of the Bay Area Chrome User's Society, September 11, 1986.

3033 Scott Boulevard, Santa Clara, CA 95054 ph: 408.727.1600 fx: 408.7271677 www.luxtron.com