

Adam E. Norton

Norton Engineered Optics

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Summary:

Before becoming an independent consultant, I had over 21 years experience as an optical designer and systems engineer in the semiconductor equipment industry. I developed microlithography equipment at Perkin-Elmer and semiconductor metrology equipment at Prometrix, Tencor, KLA-Tencor, Sensys and Therma-Wave. I was the optical designer and systems engineer for the Prometrix UV-1050 automated film-thickness measurement system that dominated its market. This design remains the basis for a series of product generations that continue to set the standards for the industry. I also helped design and systems engineer the Sensys CCD-I integrated critical dimension metrology module. This was selected by Tokyo Electron, the largest maker of semiconductor wafer tracks, to be included as an option in all of their wafer tracks.

As a consultant for several firms, I have worked on many projects involving, among other things: Semiconductor metrology equipment, large area uniform illumination, MWIR and LWIR lens design, visible and IR hyperspectral imagers, imaging polarimeters, vision systems, high-power laser patterning systems, and microscope systems.

The list below shows areas where I have particularly strong experience, but this is certainly not the entirety of my capabilities.

- UV/visible small-spot reflectometers.
- UV/visible small-spot spectroscopic ellipsometers.
- Laser-based ellipsometers.
- Semiconductor metrology.
- Optical component metrology.
- Broadband polarization optics.
- Spectrometers/spectrographs.
- Reflective objectives.
- Thin film measurement (optics & algorithms).
- Hyper-spectral imagers (Visible & IR).
- Imaging polarimeters.
- Interferometry.
- UV, Visible, & IR Lens design.
- UV-grade diamond turned optics.
- Arc lamp illumination.
- LED illumination.
- Optical alignment techniques & tooling.
- Autofocus systems.
- Near-UV refractive objectives.
- Wafer stepper alignment subsystems.
- Aerial image measurement.
- Low-stress optical mounting.
- Microlithography overlay metrology.
- Microscope optics & components.

Previous Employment:

July 2004 to Present

Norton Engineered Optics, Palo Alto, CA
Owner

- Independent consulting for many clients involving many optical projects (see above for an overview.)

April 1999 to July 2004

Therma-Wave Corporation, Fremont, CA
(Started with Sensys Instruments which was acquired by Therma-Wave in Jan. 2002.)
Principal Optical Engineer

- Took over the optical development of a small, integrated film thickness tool for use in wafer CMP machines.
- Later redesigned the optics to convert it into an integrated scatterometer to measure critical dimensions on a wafer inside a photoresist track. This product is now offered by Tokyo Electron for all their wafer tracks.
- Solved various optical issues on the Opti-Probe line of multi-technology metrology instruments.

October 1988 to April 1999

KLA-Tencor Corporation, FaST Division
(Started with Prometrix Corp. which merged with Tencor in 1994 that then merged with KLA in 1997.)
Principal Systems Engineer, Jan. 1996 April 1999.
Senior Systems Engineer, Feb. 1994 to Jan. 1996.
Systems Engineer, Oct. 1988 to Feb. 1994.

- Designed about half of all the optical systems for all the semiconductor film thickness measurement tools created by this division during my tenure. These products accounted for over \$2 billion in sales.
- Wrote measurement algorithms, diagnostic software, and calibration software.
- Worked continually with Manufacturing on component problems, vendor problems, and other issues.
- Worked closely with Field Service and Customer Support on various issues and visited many customer sites.

November 1987 to August 1988

StepperVision Inc., Sunnyvale, CA
Manager, Technology Development

- Chief development engineer for a small start-up company created to commercialize

technology invented at Xerox for automating wafer stepper set-up.

- Was responsible for converting the laboratory prototype into a commercial product.
- Developed improved algorithms.
- Gave technical presentations at trade shows and customer sites.

August 1983 to November 1987

Perkin-Elmer Corp., Microlithography Division, Wilton CT (now part of ASML)
Systems Engineer

- Was responsible for understanding and characterizing a sub-micron wafer stepper initially developed by Censor in Liechtenstein.
- Coordinated the efforts of electrical, mechanical, optical and software engineers within most of the development projects and transferred expertise to and from the engineering group in Liechtenstein.
- Project Engineer in charge of developing the manual wafer alignment system.
- Refined the existing dark-field wafer alignment system optics.
- Carried out most of the lithographic performance characterization of new stepper systems and features, developed new test reticle designs, and wrote electrical probe software.
- Provided on-site engineering support to customers when necessary.
- Identified the cause of a severe performance deficiency, and developed a solution salvaging several million dollars of nearly canceled orders.

Education:

Amherst College, B.A. Physics and Mathematics, 1983.

Phillips Exeter Academy, 1979.

Publications:

Andrew Bodkin, A. Sheinis, A. Norton, J. Daly, S. Beaven, J. Weinheimer, Snapshot Hyperspectral Imaging – the Hyperpixel Array™ Camera, SPIE Proceedings, Vol. 7334 (2009).

A. Norton, S. Cheng, T. Brunner, The Stepper Image Monitor: Sanity for the Wafer Stepper User, Semicon/West Technical Proceedings, p. 16 (May, 1988).

T. Brunner, S. Cheng, A. Norton, A Stepper Image Monitor for Precise Setup and Characterization, SPIE Proceedings, vol. 922 (1988).

U.S. Patents:

7,660,696	Apparatus for auto focusing a workpiece using two or more focus parameters
7,471,392	Polarimetric scatterometry methods for critical dimension measurements of periodic structures
7,304,735	Broadband wavelength selective filter
7,289,219	Polarimetric scatterometry methods for critical dimension measurements of periodic structures
7,248,362	Small-spot spectrometry instrument with reduced polarization and multiple-element depolarizer therefor
7,224,450	Method and apparatus for position-dependent optical metrology calibration
7,215,419	Method and apparatus for position-dependent optical metrology calibration
7,158,229	Small-spot spectrometry instrument with reduced polarization and multiple-element depolarizer therefor
7,145,654	Method and apparatus to reduce spotsize in an optical metrology instrument
7,099,081	Small-spot spectrometry instrument with reduced polarization and multiple-element depolarizer therefor
7,095,496	Method and apparatus for position-dependent optical metrology calibration
7,081,957	Aperture to reduce sensitivity to sample tilt in small spotsize reflectometers
6,919,958	Wafer metrology apparatus and method
6,909,507	Polarimetric scatterometry methods for critical dimension measurements of periodic structures
6,870,617	Accurate small-spot spectrometry systems and methods
6,778,273	Polarimetric scatterometer for critical dimension measurements of periodic structures
6,753,961	Spectroscopic ellipsometer without rotating components
6,738,136	Accurate small-spot spectrometry instrument
6,677,602	Notch and flat sensor for wafer alignment

6,667,805	Small-spot spectrometry instrument with reduced polarization
6,611,330	System for measuring polarimetric spectrum and other properties of a sample
6,583,877	Spectroscopic measurement system using an off-axis spherical mirror and refractive elements
6,572,456	Bathless wafer measurement apparatus and method
6,323,946	Spectroscopic measurement system using curved mirror
6,184,984	System for measuring polarimetric spectrum and other properties of a sample
5,917,594	Spectroscopic measurement system using an off-axis spherical mirror and refractive elements
5,859,424	Apodizing filter system useful for reducing spot size in optical measurements and other applications
5,747,813	Broadband microspectro-reflectometer
5,486,701	Method and apparatus for measuring reflectance in two wavelength bands to enable determination of thin film thickness

Published pending U.S. patent applications:

20080088840	HYPERSPETRAL IMAGING SYSTEMS
20060072109	Hyperspectral imaging systems

Software Skills:

Expert using Zemax, TracePro, Matlab, Super-Oslo, and Mathcad. Moderate experience with CodeV, SolidWorks, and FilmStar.

Programming languages: C, Basic, Pascal, Fortran.