Polar Kerr System for Perpendicular MRAM

Magnetic Mapping of Perpendicular MRAM Wafers up to 300 mm

The Polar Kerr System for MRAM utilizes the polar Magneto-Optical Kerr Effect (MOKE) to characterize the magnetic properties of multi-layer wafers used in the development and manufacturing of perpendicular MRAM. Utilizing a non-contact full-wafer measurement technique, the system creates a map of the magnetic properties of entire wafers up to 300 mm. The system is available in a manual loading or fully-automated configuration for use in R&D and/or production. Using the proprietary direct field control technique of MicroSense magnetic metrology tools, the Polar Kerr for MRAM system offers high field capabilities and excellent field resolution to characterize free and pinned layer properties in a single system. The metrology is based on the production-proven MicroSense Polar Kerr for PMR disks measurement system used worldwide for the post-deposition metrology of HDD disks.

BENEFITS

• Non-contact mapping of the magnetic properties of perpendicular MRAM wafers up to 300mm.

• Maximum field of ± 2.4 T for full stack measurements, field resolution of 0.05 Oe for free layer measurements in a single system.

• Measurement of patterned magnetic features using integrated high-resolution camera and Optical Pattern Recognition (OPR) software.

• Characterization of multi-layer soft and hard magnetic films.

• Field align process step of full wafers.

MAGNETIC CHARACTERIZATION

The system utilizes the MicroSense proprietary high sensitivity Polar Kerr detection technique and direct field control system. This makes it possible to measure multi-layer films used in advanced perpendicular MRAM. Direct Field Control ensures no field overshoot or pole tip remanence influencing the measurement, even if high fields have been used to saturate the entire magnetic stack.
Thus, it is possible to map the spatial variation of both the pinned (Figure 1) and free (Figure 2) magnetic layer properties over the entire wafer by simply running different measurement recipes.
Utilizing the optional camera and OPR software module, the system can also be used to measure patterned wafers.

PROCESS CONTROL

The system measures full hysteresis loops of any location on the wafer. A complete, ± 2.4 T hysteresis loop with over 16,000 data points can be measured in less than 20 seconds. Proprietary extraction software automatically computes a large variety of parameters, such as pinned layer exchange, coercivity, free layer exchange, coercivity, anisotropy field, etc. The mapping results are displayed both graphically and in tables and can be saved to a network (Figure **3**).

MODULAR DESIGN

Camera-Based Vision System: By utilizing a joystick-based user-friendly software interface, high resolution camera and optics, it is possible to visualize the exact location of the wafer to be measured.

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Optical Pattern Recognition System: The OPR Module makes it possible to automatically locate and move to structures on a patterned wafer. Using this capability, patterned wafers can be automatically measured without operator involvement.

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Fully Automated 300 mm EFEM with SECS/GEM Automation: This combined hardware/software option makes the tool fully automated for use in volume production. Using an integrated industry-standard EFEM front-end and SECS/GEM factory automation software, wafers can be measured without having to be manually handled.

Field Align (Magnetic Set) Process Step of Full Wafers: This option allows the tool to be used for rapid field alignment, an important process step in perpendicular STT-MRAM, of full wafers at a programmable DC field up to the maximum field of the system.

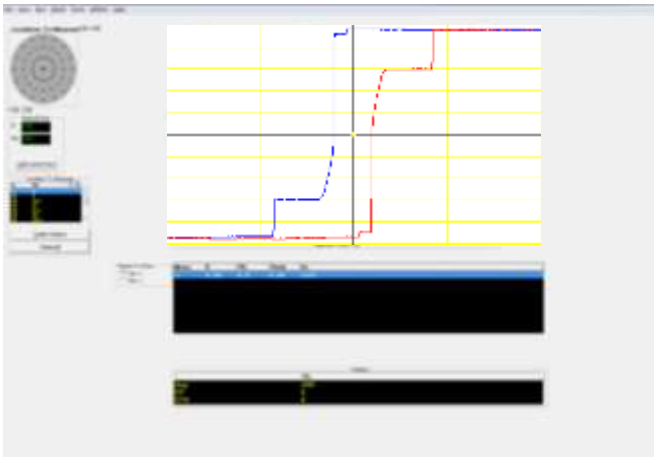

Figure 1. High Field (Full Stack) Measurement of a Perpendicular MRAM Multi-Layer Stack.

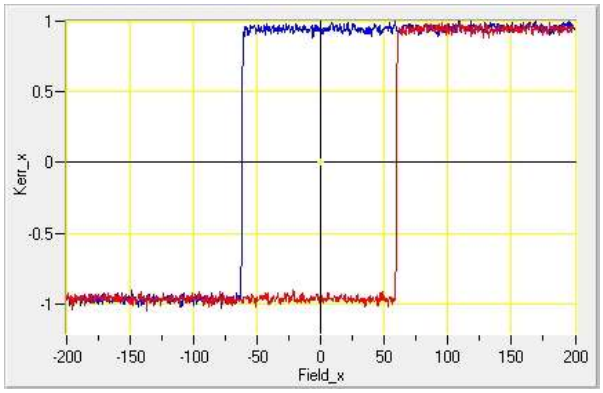

Figure 2. Low Field (Free Layer) Measurement of a Perpendicular MRAM Multi-Layer Stack.

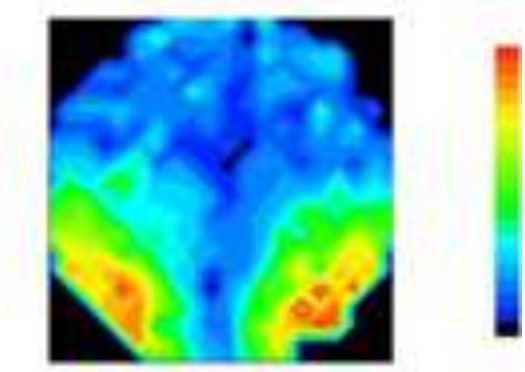

Figure 3. Full Wafer Maps Analyze Magnetic Uniformity of the Magnetic Layers of the MRAM Multi-Layer Stack.