HYDRA2: An Automated Product QC System that Eliminates NdFeB Coating Defect Risk
Magnet Quality Inspection Processes Summary

Magnet manufacturers establish process controls to ensure efficiency in production and limit Critical to Quality (CTQ) failures in field strength, reversible loss coefficients, size tolerances, and corrosion resistance. In order to communicate controls, magnet suppliers report their process controls to customers using standard metrics (e.g., Cpk, Ppk, process FMEA analysis, GR&R, etc.) that exhibit the efficiency of their internal processes. No matter what the report shows, the magnet company’s process must accept a certain amount of failures per production batch with the aim to continually reduce the number of failures per production batch.

To mitigate the risk of failures in the final applications and strengthen the presentation to a potential client, magnet manufacturers implement product controls like sampling procedures for further testing. For example, ISO 2859-1 is a tool that helps suppliers and customers define sampling plans for different inspection levels (reduced, normal, tightened) in order to agree on standardized sampling procedure. Companies use sampling procedures because 100% product inspection has always been considered impractical and uneconomical.

However with all of these control measures, some customers report poor corrosion resistance as leading cause of magnet failure, in other words, poor coating quality. These coating failures are a result of outdated process controls and poor risk mitigation plans that follow inferior inspection standards.

As a new market entrant and innovative magnet manufacturer, Urban Mining Company, aims to exceed customer expectations by raising current industry quality control and process control standards by establishing a new normal.
In order to solve this quality problem UMC is investing in state of the art process and product control technology to reduce the impact of the known sources of process variability - human interaction, machine variability, measurement process variability, environment due variability, sourcing material variability and method due variability.

**HYDRA: High Yield Definition Resolution Acquisition System**

UMC is building an automated vision system, HYDRA2, which will conduct 100% product inspection at a high throughput, relieving the customer from uncertain quality levels. HYDRA2 can check continuous variables like dimensions and coating thickness, with 2 um and 10 um accuracy, respectively, while keeping repeatability under 2 um. Attribute variables, like surface defects, are measured with 2 um accuracy and 100% repeatability.

Currently other automated inspection systems can only measure dimensions with an accuracy range between 20 um and 100 um and repeatability range from 50um to 20 um. The current technology is limited by computational speed, which forces the application designer to work with lower resolution detectors in order to achieve a high throughput.

Because most vision systems provide unreliable results magnet producers implement additional processes to double check measurements with the aid of manned visual inspection and ISO 2959-1. This system creates an economical disadvantage because the manned visual inspection needs a considerable workforce in order to check the daily parts amount required to meet production schedules. Additionally, the operators use measurement methods that cause a performance disadvantage because standard micrometers are often not regularly inspected and calibrated. The measurement itself is subject to bias due to the operator’s eyes fatigue or tendency to rush when pay is dependent on the amount of processed parts.

HYDRA2 on the other hand is fully automated with a push of a button and calibrates in less than one minute, therefore ensuring accurate part analysis before each delivered batch.
Coating Process Control

The ability of a coated magnet to resist to corrosion depends on the surface quality after machining processes and by the coating process. Pinholes and bubbles in the coating, for instance, are cause of coating failure resulting of poor surface finishing and preparation. Bubbles can be formed when the magnet surface is not properly cleaned, for example residual grease is left on the magnet surface causing poor adhesion of the coating layer. Pinholes can be caused by surface roughness higher than 1 um which allows the acidic solution, used in the activation process, to stay on the magnet even after rinsing and prior to the deposition of the coating layer. The acid droplets will ultimately go through the coating offering a spot for corrosion to attack.

The key to UMC’s approach in the process control measurement system is to eliminate the human factor, through the implementation automated measuring system whenever possible. For example, UMC is able to produce surface finishing with roughness lower than 0.8 um RMS thanks to state of the art surface grinder machines. Laser profilers control surface roughness on a sample plan set up to ensure a deviation from the actual value is less than 0.1 um.

Conclusion

HYDRA2 will identify failures before any magnets are shipped to the customer, therefore providing the customer with a ZERO defected magnets related to coating and size CTQ parameters defined by the customer.

Process control is always necessary for increasing efficiency of a process. HYDRA2 will prevent delivery of defective parts to a customer. However, our ultimate goal is to control the process so well that HYDRA2 will not identify many defects so we will achieve a low attrition rate.