Automated Quantitative Microscopy in Materials Research and Quality Assurance

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- ☒ Computational Imaging
- ☐ Computer Vision and Machine Learning
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Abstract

Major changes occurred in the field of computer based image processing and automation of microscopes. Today's hard- and software provides a variety of tools for consistent quantification of microstructures using automated microscopes. Quantitative determination of volume fractions of phases, grain size, defect size and morphology, geometry as well as texture, alignment or distribution of objects can be realized in 2D and 3D. Quantification helps to understand complex coherences. Condensation of data in microscopic quantification allows better understanding, interpretation and comparison of data. The possibility to correlate data, e.g. production parameters with microstructure features, is of considerable benefit for the development of sustainable knowledge.

However the full scope of quantitative microstructure analysis cannot be obtained without automation, the combination of techniques and imaging intelligence in analyzing complex structures. For instance the measurement of geometry parameters or the identification of inhomogeneities in components requires scanning of large areas and processing of large data in 2D, as well as if required in 3D.
We will demonstrate use cases of automated and correlative microscopy for materials for energy applications, sustainable mobility and additive manufacturing. Examples for intelligent algorithms to analyze defects and inhomogeneities in powder based components, e.g. sintered and additive manufactured parts are shown. It is demonstrated how quantitative image analysis can help to measure

intrinsic magnetic properties and anisotropies in magnet materials for E-Motors, by using polarization microscopy and correlative microscopy. New approaches for machine vision learning for the quality control for Li-Ion batteries to automatically identify geometries of the layout and the microstructure of the electrodes and structural defects are shown. We also demonstrate how a correlative approach of combining three-dimensional X-ray microscopy with a Crossbeam microscope helps to deeper analyze battery materials and to gain a higher level of knowledge.

References

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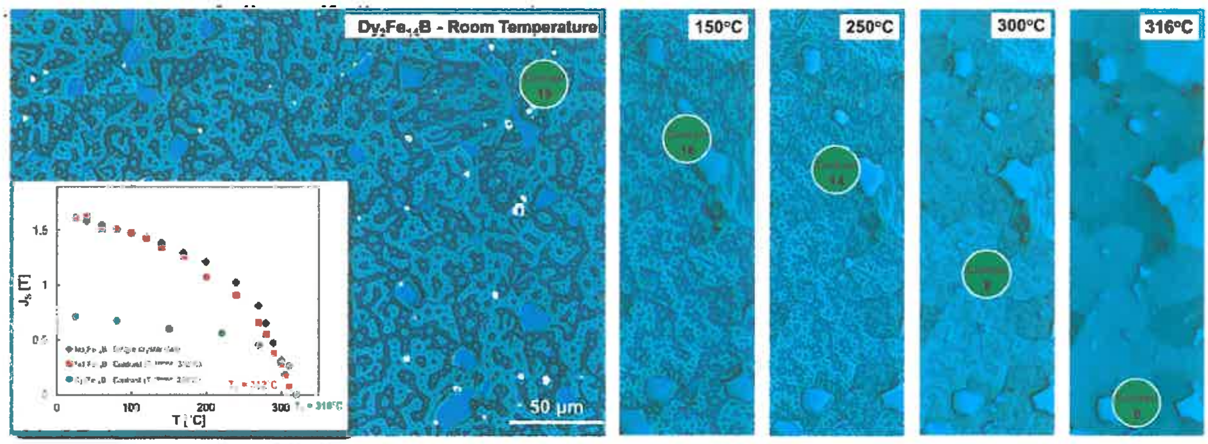

Figure 1. *Domain structure of $Nd_2Fe_{14}B$ and $Dy_2Fe_{14}B$ using Kerr effect and hot stage. Temperature depending contrast is in good agreement with literature data of the saturation magnetization and T_C*

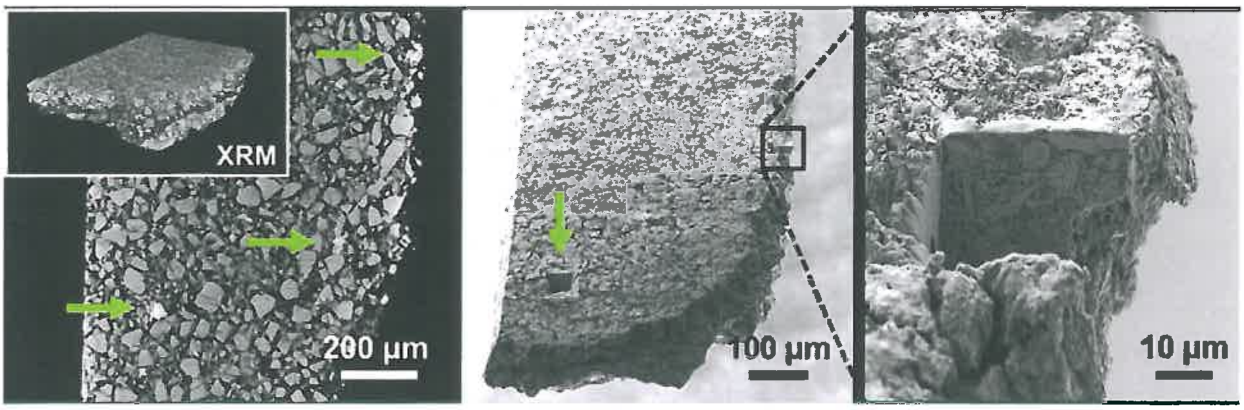

Figure 2. *Multi-scale characterization of Lithium ion battery cathode material by correlative X-ray and FIB-SEM microscopy*