Workshop »Digital Data creates value – recognising and exploiting opportunities«

Visualizing the unseen: AI-driven surface analysis for uncovering hidden sample properties

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Hyperspectral imaging (HSI) is an optical inspection technology, which combines spectroscopy and imaging. Sample properties that are particularly important for quality assurance, such as layer thickness, material composition but electrical conductivity as well, can be evaluated quickly and spatially resolved over a wide sample area. The technology offers the possibility to be used at-line in sheet-to-sheet processes but also in-line in roll-to-roll processes.

However, a major challenge in HSI is the extraction of relevant information from huge data sets that are often noisy and subject to overlapping effects such as scattering and absorption. A conventional interpretation of the spectra is not possible. Machine learning (ML) and artificial intelligence (AI) methods are the tools of choice for efficient data analysis in HSI. For example, regression methods can be used to predict properties such as layer thickness, while classification methods can be used to detect defects. AI can also be used to predict derived properties such as water vapor transmission rate (WVTR) of barrier layers or the adhesive strength of joints. A wide variety of algorithms can be used for data analysis in HSI, ranging from typical “chemometric” methods such as partial least squares (PLS) to more complex ML methods such as random forest models or neural networks. By using these methods, it is for example possible to continuously and accurately measure layer thickness in roll-to-roll (R2R) coating processes (Figure 1), as well as sort black plastics or detect defects and variations in semiconductor wafers.

In this talk, we will provide an introduction to hyperspectral imaging, including the hardware and software required for data acquisition and analysis, and discuss the ML and AI methods that are essential for the successful analysis of HSI data. We will also present relevant examples of HSI applications, demonstrating how this technology can be used to address challenging quality assurance problems in various industrial settings.

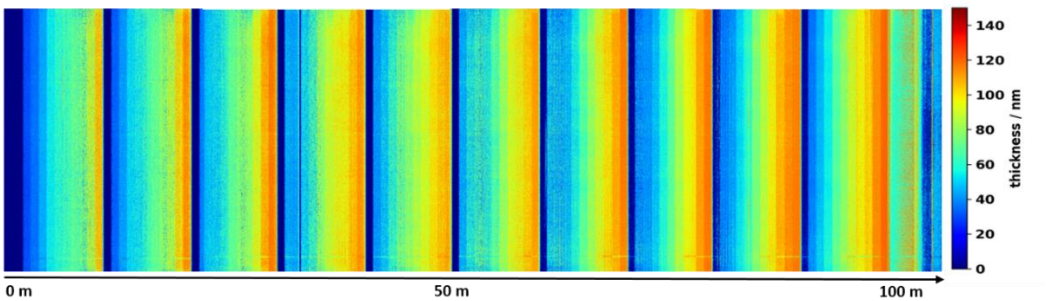

Figure 1: Predicted thickness of an ITO layer on a 110 m PET substrate with a spatial resolution of < 0.5 mm.