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New Insights in Materials Characterization – Spectral Computed Tomography

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Micro-CT can be used to study the structure of samples from a centimeter to micrometer scale. One of the main limitations in this, however, is the inability to perform true material identification without prior knowledge, as contrast inside a micro-CT scan is mainly caused by the atomic number of the sample. Also density, used x-ray energy, the x-ray spectrum and the used detector have influence on the achieved grey values and contrast in a dataset.

We present integration of an energy-sensitive spectral detector inside laboratory-based micro-CT scanners: the TESCAN PolyDET™.

Using the TESCAN UniTOM XL, both traditional (attenuation-based) and spectral tomography and reconstruction were performed. Spectral measurements were acquired using the mounted TESCAN PolyDET™. This way, not only the attenuated intensity of the X-ray beam when travelling through samples could be measured, but the entire energy spectrum (20-160 keV) of the X-ray beam was measured by the TESCAN PolyDET™. Measurements were performed on various types of samples, from simple plastic specimen as proof of concept to economically important samples such as batteries and raw materials for the mining industry.

In this work we show the first results of the method for the investigation of porous media. The most obvious use of a spectral detector enhances micro-CT with EDS-like capabilities for mineral identification. Spectral imaging can positively identify gold grains inside an ore sample, even without prior knowledge or when gold grains are so small that they are masked by the partial-volume-effect of traditional micro-CT. It is also positive to differentiate multiple important ore materials inside rock specimen, or to do rapid screening of different types of limestones and sandstones, important for energy storage solutions. The information obtained can later be used to calculate more indirect properties, such as relative saturation inside the measured porous media. More advanced analytical capabilities can be used to get true contrast between materials – independent of the X-ray energy used to scan them, get more insights into density differences between materials or perform dual-energy CT scans in just one scan – without any assumptions. Spectral CT can also diminish or remove any artefacts originating from the polychromatic nature of the X-ray beam used in micro-CT, of which beam hardening is the best known.

All results show the large potential of spectral CT in enhancing attenuation-based micro-CT and providing new and unique insights in all types of materials.

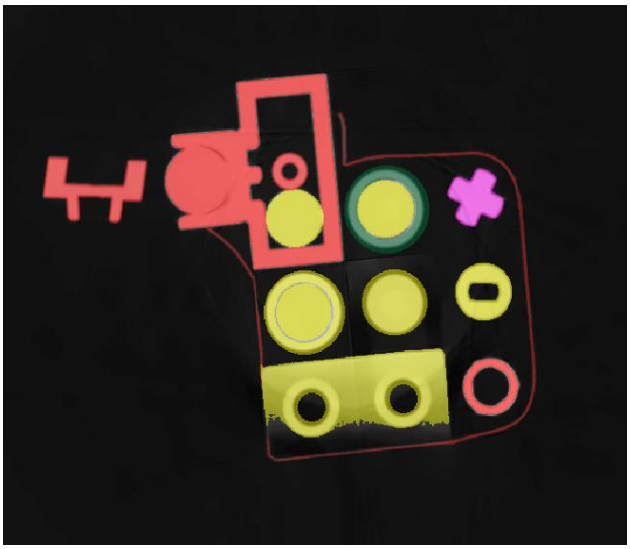

Figure 1. Lego sample segmented into different types of plastic.

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