doi:10.1017/S1431927622002690
Microsc. Microanal. 28 (Suppl 1), 2022

Five Years of Live Chemical Imaging: From the First Live Maps to Real-time Dynamic Imaging Combining Morphology and Chemistry with Overlap Corrected EDS Data

Simon Burgess[1], Anthony Hyde[1], Haithem Mansour[1], Philippe Pinard[1], John Zhang[1], Peter Statham[1] and Rosie Jones[1]

[1.] Oxford Instruments NanoAnalysis, High Wycombe, United Kingdom
* Corresponding author: simon.burgess@oxinst.com

Live chemical imaging (LCI) is one of the most significant advances in technology for X-ray mapping using energy-dispersive spectrometers (EDS). It enables rapid and unambiguous sample investigation and navigation in the SEM through the combination of secondary and/or backscatter electron signal data with EDS X-ray compositional information to provide simultaneous morphological, chemical, and elemental images of a sample. The information is provided at rates significantly greater than 1 frame per second making it applicable for investigation in dynamic situations, such as when the magnification is changing or the stage is moving. If the user pauses, the collection switches automatically to integrate the signals to provide detailed images in seconds that can be used for more detailed map and image processing methods. Adding real time elemental information to sample investigation aids the understanding and analysis of complex or unfamiliar samples. Phases, chemistry and micro-structure of a sample are clarified and the optimal sites can be found for those map acquisitions that will answer the scientific question, explain the situation in a report, or provide the detailed spatial information for a publication. LCI helps in many applications, for example in the investigation of counterfeit tablets [1].

Since its introduction in 2017 [2], hardware and software has been developed to improve response and refresh of the electron and X-ray elemental information to approach the interactive experience a user would obtain from using just a secondary or backscatter electron image. In 2021 we introduced second-generation technology [3] that presents all the information in a single combined image. The electron image signal controls the brightness and contrast of each pixel and hue is derived from the compositional information for a number of chosen elements. Figure 1A shows the quality of information for a single dynamic frame of LCI from an additive manufacturing raw material powder. Maps for carbon (red), aluminium and titanium (green), silicon (blue) and tungsten (magenta) are combined with a secondary electron image to show the morphology. Fig 1B-E shows elemental maps for silicon, tungsten titanium and carbon from the same frame, also displayed during LCI if required. This level of information and detail is ideal for finding areas for analysis and for gaining an understanding of the sample as it is explored, because the information is presented continuously and there is no need to stop to acquire a map just to see what is present. Point spectra collection is available but is needed far less frequently due to the level of elemental information in the live display.

Here we report on further LCI developments. The "TruMap" algorithm that processes spectral information in each pixel to remove background and deconvolute X-ray peaks has been optimized so that this processing is achieved fast enough to meet frame refresh requirements. This new fast algorithm makes no compromise on the accuracy of the background subtraction and peak deconvolution. In Figure 2 we show a single dynamic frame collected from the same region of the powder sample, however in this case TruMap processing has been used during LCI. Figure 2A looks very similar to the previous combined image shown in Figure 1A, however, the 3 differently coloured small spheres have changed colour from blue to magenta. This is because the TruMap algorithm has deconvolved SiK lines from WM lines, and removed the artefact SiK from the areas that are pure tungsten spheres. Figure 2B and C show the TruMaps from the same frame showing the removal of the Si signal caused by the overlap with WM. Therefore, LCI can now report elemental variations even where characteristic peaks overlap.

LCI is being used to understand ever more complex samples with different phases, elements, and microstructures. In this presentation we will show other examples from alloy, geological, and electronic samples.

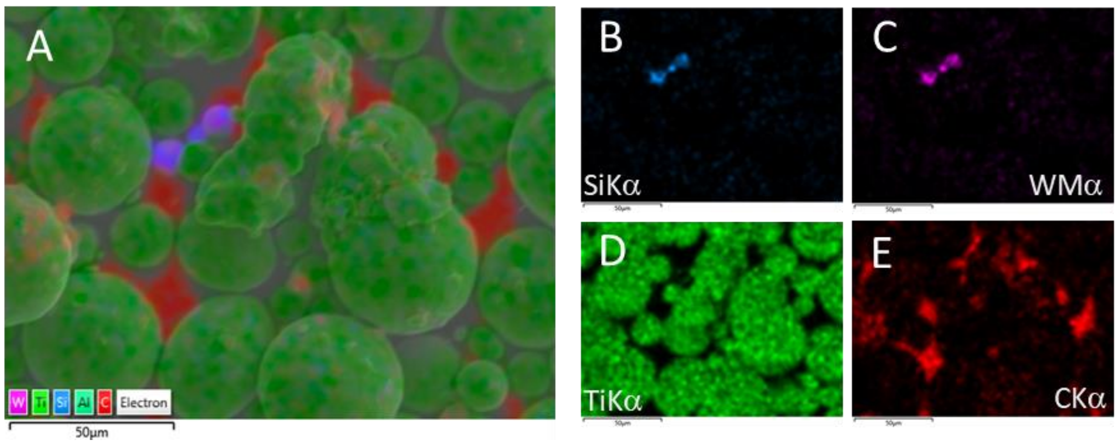

Figure 1. Single frame dynamic mode LCI shows the data presented to a user in each frame when the sample is moving or magnification changing. A. Combined Image with SE and X-ray information. B silicon map, C. tungsten map, D. titanium map, E. carbon map.

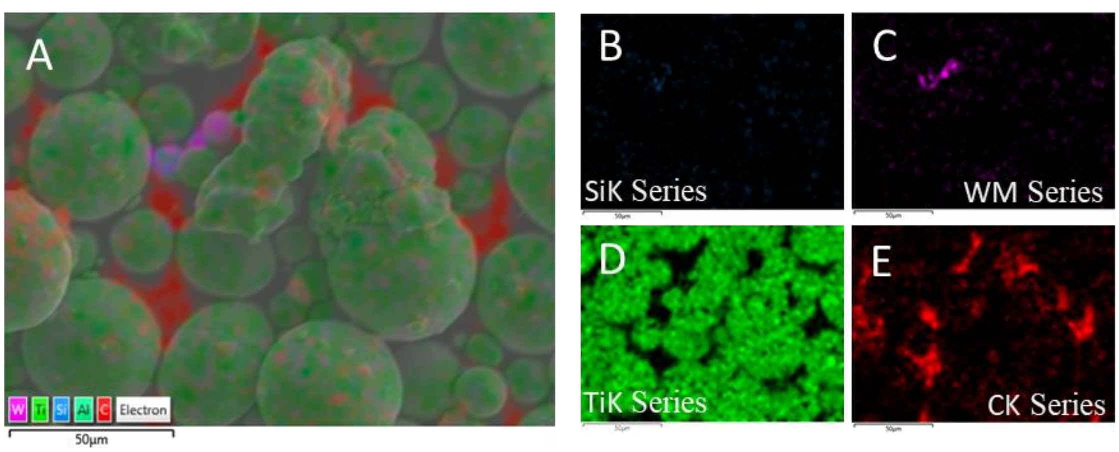

Figure 2. Single frame dynamic mode LCI with TruMap peak deconvolution and background removal. A. Combined Image with SE and corrected X-ray information. B silicon TruMap, C. tungsten TruMap, D. titanium TruMap, E. carbon TruMap.

References:

[1] A Hyde et al., Microscopy and Microanalysis, **25(S2),** (2019) doi:10.1017/S1431927619007116
[2] P Pinard et al., Microscopy and Microanalysis, **24(S1)**, (2018) doi:10.1017/S1431927618003616
[3] S Burgess et al., Microscopy and Microanalysis, **27(S1)**, (2021). doi:10.1017/S1431927621006723

https://doi.org/10.1017/S1431927622002690 Published online by Cambridge University Press