

## *sisu* CHEMA *in dairy applications*

SisuCHEMA is a perfect chemical imaging workstation for applications within the dairy industry. It brings the simplicity and speed needed for measuring any dairy sample. SisuCHEMA employs a push-broom imaging technology, which provides several outstanding advantages for the user; highest speed, lowest heat load from illumination, and possibility to image series of samples in one measurement, all necessary features for providing the highest efficiency while keeping fresh dairy samples without change.

**N**ear Infrared (NIR) spectroscopy is a technique frequently used for characterization of materials and products in the dairy industry. It has proven to be a valuable tool for determining various properties of dairy samples, including solid content, cheese ripeness and milk coagulation to mention a few. The sisuCHEMA workstation (picture 1) extends the traditional NIR spectroscopy with high resolution imaging; it provides detailed information on the chemical components, their quantities and distributions within the sample. It is invaluable information for the characterization and quality assurance of products, where the functionality of the material is dependent on its chemical and physical structure.

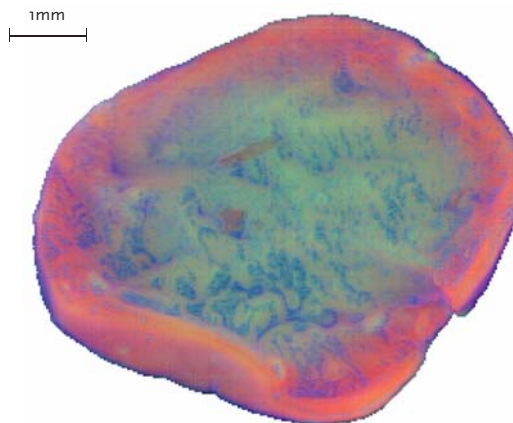
SisuCHEMA comes with various sample trays that can be loaded into the instrument while containing dairy samples (picture 2). SisuCHEMA's push-broom technology along with all its advantages provides a rapid measuring procedure, a pre-requisite for keeping the often moist and fresh dairy samples unimpaired. The recorded hyperspectral images are then easily transferred to the analysis software Evince, where chemical composition and its distribution can be analyzed and viewed with various types of visualizations (picture 3).



Picture 1. SisuCHEMA imaging workstation



Picture 2. A sample tray holding cheese granules has been loaded into sisuCHEMA, here fitted with a macro lens, which images the samples at 30 micron resolution.



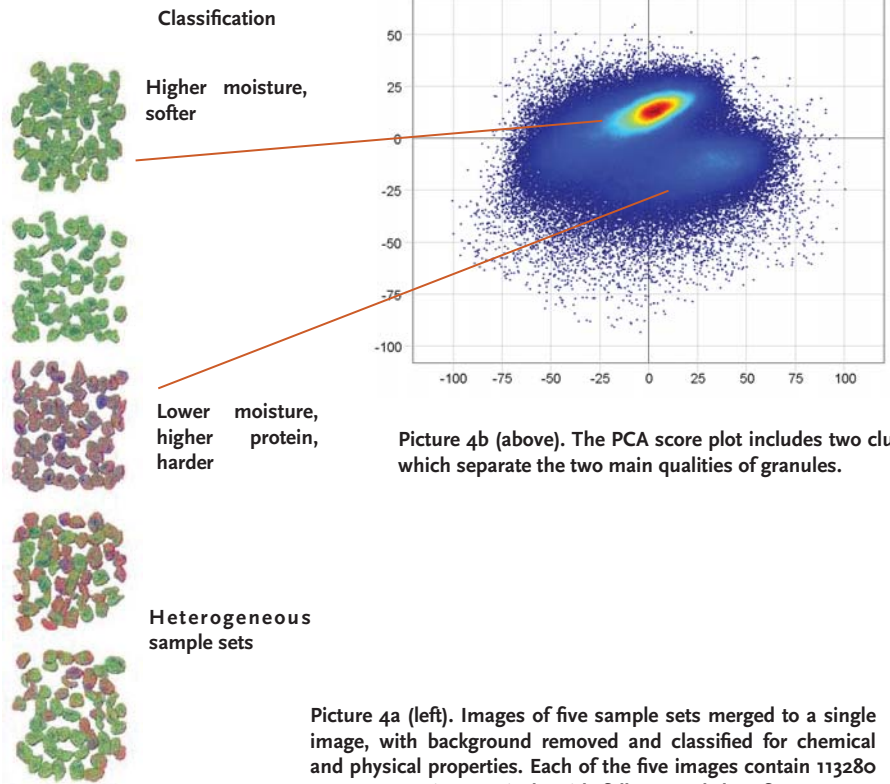
Picture 3. Pseudo-colored visualization of a cut cottage cheese granule created from an NIR image of the first three principal components. Visualization is created in Evince analysis software and it shows different physico-chemical structure at the surface of the granule.

## QUALITY MONITORING IN COTTAGE CHEESE

Being a pushbroom scanner, sisuCHEMA can scan a sample of arbitrary length, as there is no limitation in the number of scanned image lines. This means sisuCHEMA can scan several different samples in the same hyperspectral image. In processing, images can also be merged together to a mosaic image.

The shown merged image representation (picture 4a) consists of five sisuCHEMA scans acquired for different qualities of cheese granules. The whole mosaic image has been decomposed into principal components using PCA and the first component was here used for the separation between background and granules.

With the background removed, the different properties of the samples become more apparent. As each pixel contains a nearly full NIR spectrum (970-2500 nm), it is possible by means of multivariate methods to distinguish samples of different chemical properties. The PCA score scatter plot (picture 4b) shows two clusters of observations (pixels) separating the two main qualities of granules. In this particular case, the granules were analyzed for solid content, moisture and protein. In the pseudo-colored visualization (picture 4a) from the first three principal components, the greenish granules have low solid content, high moisture and are low in protein. The reddish granules have higher solid content and are richer in protein.



Picture 4b (above). The PCA score plot includes two clusters which separate the two main qualities of granules.

Picture 4a (left). Images of five sample sets merged to a single image, with background removed and classified for chemical and physical properties. Each of the five images contain 113280 NIR spectra (image pixels with full spectral data from 970nm to 2500nm). SisucHEMA acquired each image in less than 5 seconds, which is more than 10 times faster than with any other hyperspectral imaging technique on the market.

## SisuCHEMA performance specifications

Optical and technical characteristics	SWIR	NIR
Operation mode	High speed push-broom hyperspectral	
Spectral range	970 - 2500nm	900 - 1700nm
Spectral sampling/ pixel	6.3 nm	4 nm
Spectral resolution	10 nm	6 nm
# spatial pixels/ line	320	
Pixel size on sample	Scalable from 30 to 300 microns	
Field of view on sample	Scalable from 10 to 100 mm	
Maximum sample size	100 x 100 x 40 mm (WxLxT)	
Scanning rate	100 hyperspectral line images/ s (max), corresponding to - 3 mm/s with 30 micron pixel - 30 mm/s with 300 micron pixel	
Typical scan time	3 to 10 s for an image with 320 x 320 spatial pixels and full 256 spectral bands	
Illumination	Diffused line illumination	
Data format	BIL file format, Evince end ENVI compatible	
Instrument calibration	Instrument is delivered with spectral calibration. Image data is automatically calibrated to reflectance by measuring an internal standard reference target before each sample scan.	