Perovskite Nanocrystals Hyperspectral Imaging and Characterization

Perovskite nanocrystalline materials hold great promise for the future of photovoltaics. This is due to their potential low cost to manufacture and high levels of absorption of visible light, which can be very precisely tuned at the individual nanocrystal level. However, there are still hurdles to overcome in their development before they can effectively challenge silicon based materials in the solar energy market. One of the biggest issues yet to be resolved is maintaining their stability over time in a wide range of environmental conditions.

Solving this problem requires a fast, high volume method for evaluating perovskites in a wide range of environmental conditions. CytoViva's Enhanced Darkfield Hyperspectral Microscopy (EDHM) is an ideal method to accomplish this evaluation of perovskites and related crystalline structures.

Hyperspectral images captured with the CytoViva system look similar to optical images. However, each pixel of the hyperspectral image contains the spectral response for that pixel's spatial area. Using integrated hyperspectral image analysis software, the unique spectral response of nanomaterials can be identified and easily mapped throughout the sample.

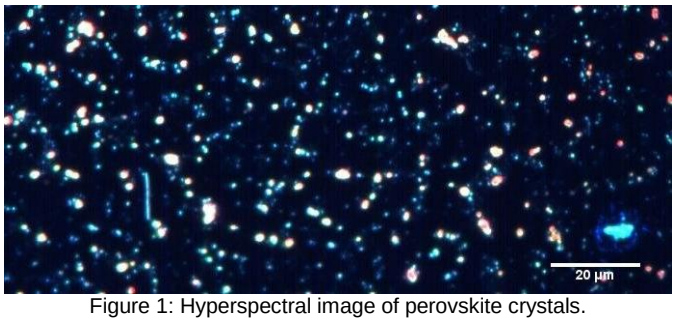

Figure 1: Hyperspectral image of perovskite crystals.

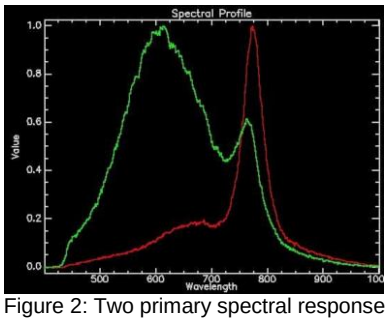

Figure 2: Two primary spectral response characteristics of the perovskite crystals from figure 1.

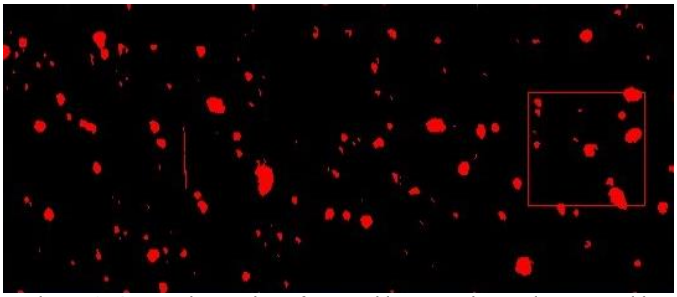
Figure 3: Spectral mapping of perovskite crystal sample areas with strong reflectance spectrum at ~780nm and strong absorbing properties in the visible range.

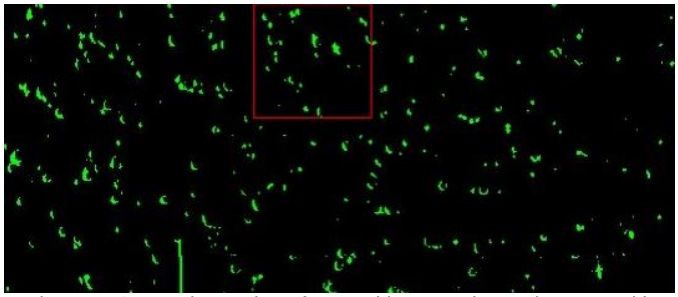
Figure 4: Spectral mapping of perovskite crystal sample areas with strong reflectance spectrum (weak absorbance) in the visible range.

With CytoViva's EDHM, an image area as large as 250µm x 250µm can be captured in 2-3 minutes with pixel sizes of ~210nm square when using 60x magnification. Each pixel in the hyperspectral image contains the complete visible near infrared (VNIR) optical spectral data from 400nm - 1,000nm with better than 2nm of spectral resolution. The spectrum from each pixel of this hyperspectral image can be instantly queried with powerful image analysis software. Additionally, spectral mapping that identifies unique spectral elements within the sample can be quickly and easily conducted. This is critical analysis for perovskite samples as measuring the stability of their spectral response over time and in changing conditions is key to improving their performance.

See above in figure 1, a CytoViva EDHM image of perovskite nanocrystals that provides detailed insight on nanocrystal shapes and variations in size. Each pixel of this image contains the VNIR spectral response (400nm - 1,000nm) for that pixel's spatial area. Figure 2 represents the two most commonly observed spectral response characteristics identified in the sample.

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These two reflectance spectra demonstrate that some areas of the sample are highly reflective across the visible range (green spectrum) while other areas of the perovskite samples strongly absorb in the visible range and have a strong reflectance peak in a narrow range at ~780nm.

Using custom developed hyperspectral image analysis software provided with the system, it is easy to spectrally map each pixel in the image containing the two predominant spectral characteristics. Figure 3 maps all areas that have high absorbance in the visible range, while figure 4 demonstrates spectral mapping of those areas with strong reflectance values in the visible range.

CytoViva's technology is currently utilized in hundreds of research laboratories across the world engaged in nanoscale research similar to the example shown. Please contact us at info@cytoviva.com to learn more about CytoViva's Enhanced Darkfield Hyperspectral Microscopy and how it can advance your research initiatives. We can discuss test imaging of your samples at our laboratory or conduct an on-site demonstration at your research facility if appropriate.