POSTER PRESENTATIONS I4:

Colored micrographs significantly outperform grayscale ones in modern machine learning: Insights from a systematical analysis of lithium-ion battery micrographs using convolutional neural networks

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While digital microscopy image analysis self-evidently shifted from grayscale to colored images years ago (1), it is still an open question if the information content of more efficient grayscale images is sufficient for powerful modern machine learning approaches. This question is an important one for practitioners since one-layer grayscale images can be stored and computed much more efficiently compared to multi-layer colored images. In addition – since a broad range of modern machine learning algorithms were built on the information content paradigm (such as Shannon’s entropy in C5.0 or the Gini coefficient in Random Forests) – it is also very interesting from a theoretical point of view to know if colored images contain more relevant information content in comparison to grayscale images. To contribute to this question we systematically analyzed a series of greyscale versus colored material images from quality assessments of lithium-ion batteries. In this poster we report promising results from the Deep Convolutional Networks test series. Deep Convolutional Networks belong to the leading edge machine learning approaches that are working very well in image classification tasks [2, 3]. As a result, we found a significant increase in the classification accuracy of lithium-ion battery anode and cathode material quality, by using colored micrographs instead of monochrome ones. We showed that Convolutional Neural Networks are able to extract valuable information from RGB channels, when compared to grayscale micrographs. We used a two layer Convolutional Neural Network architecture, trained to classify micrographs into “OK” and “Not-OK” classes (Figure 1). For training and testing purposes, we used 122 colored 128 times 128 pixel micrographs captured by a ZEISS Axio Imager.Z2 Vario microscope. We converted the colored images into grayscales using the ITU-R 601-2 luma transformation. In more detail: When using RGB colored micrographs, we found a 50% improvement of the area-under-the-curve measurement and a 14.2% increase in accuracy (Figure 2). Both values indicate a substantial gain in the information content of colored images.

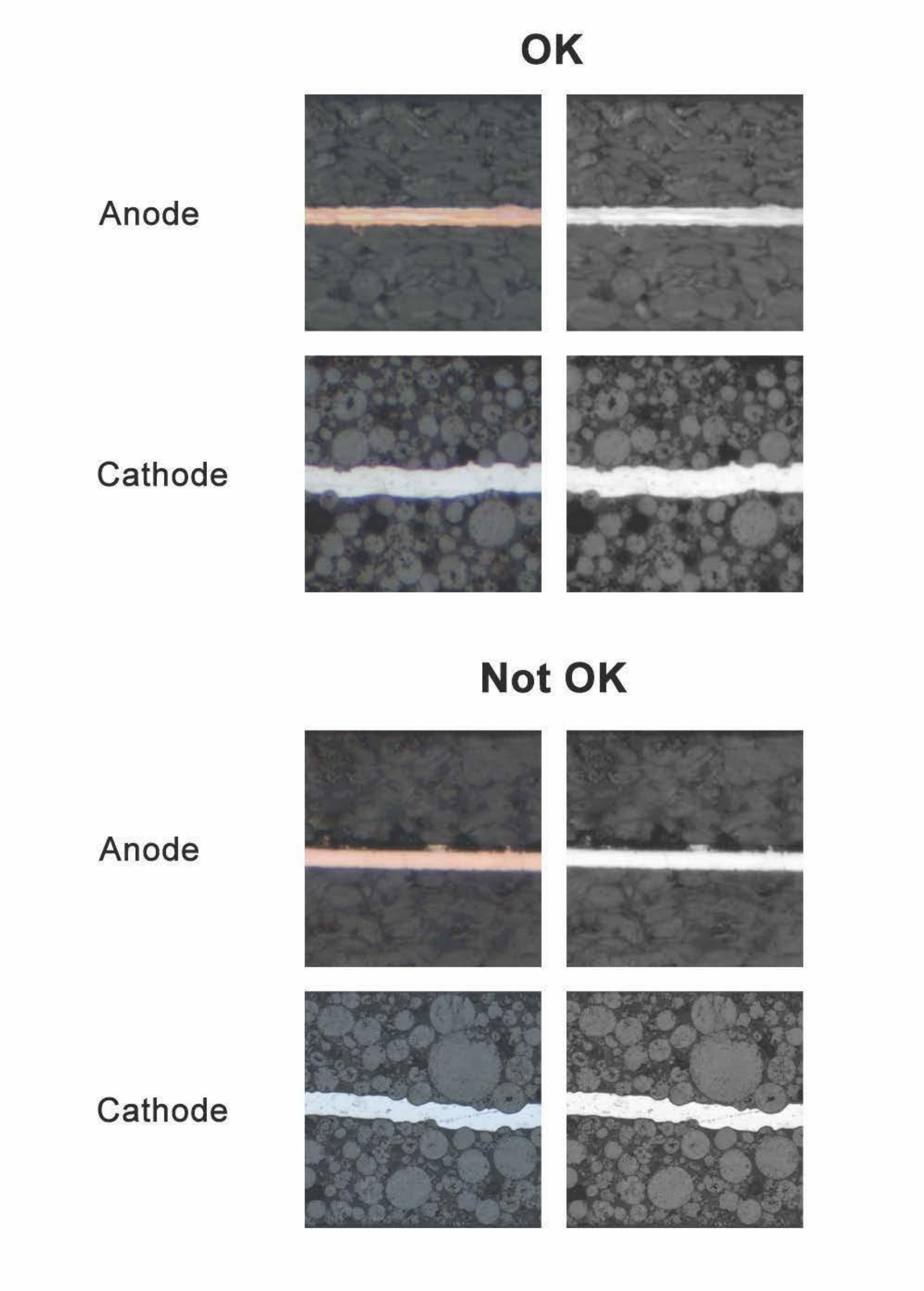

Figure 1. Examples of colored and non-colored micrographs from quality assessments

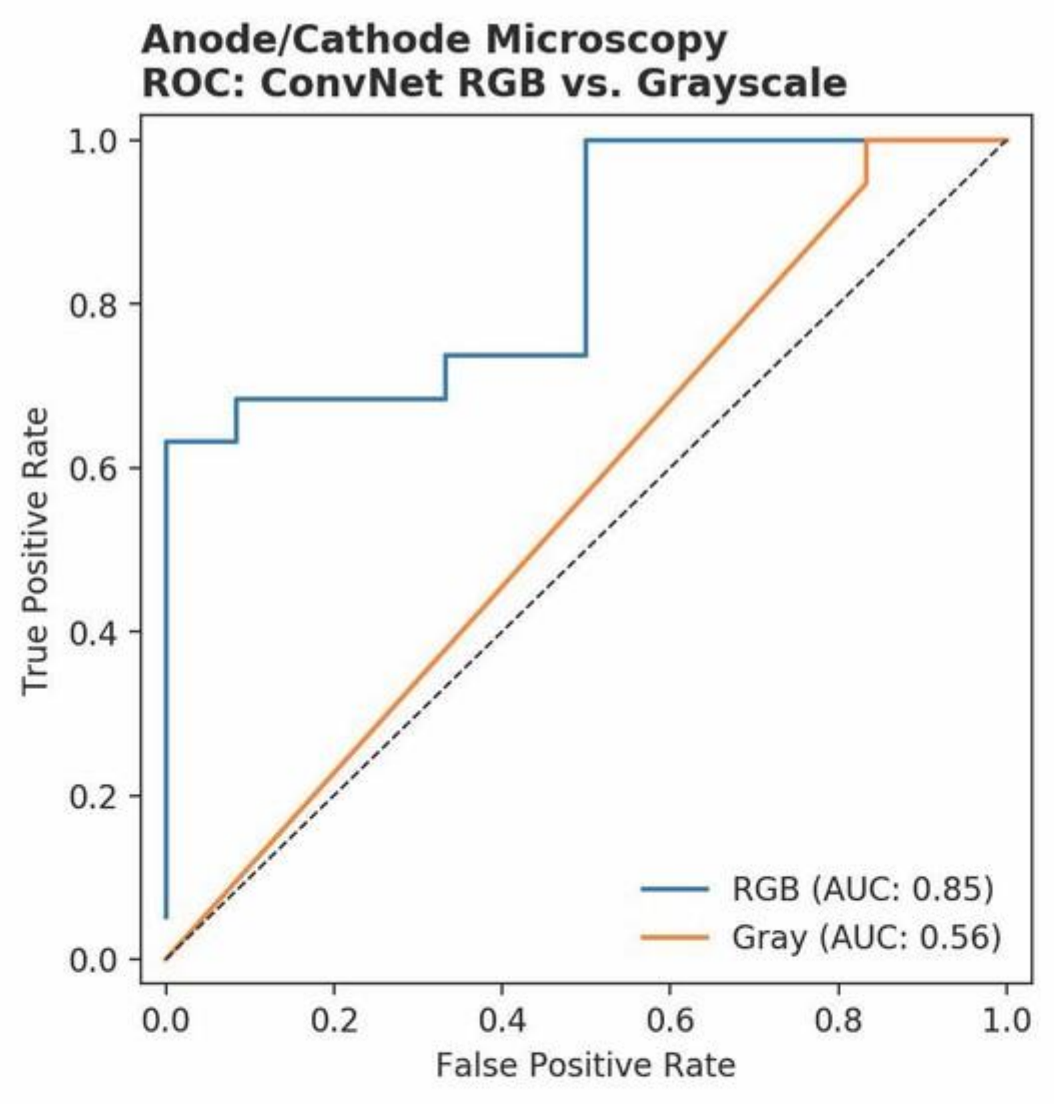

Figure 2. Performance indicators of trained convolutional network

References:

1. K.R. Castleman, Biol. Bull. 1994 (1998) 100-107.

2. N. Jones, Nature 505 (2014) 146-148. 3. Y. LeCun et al., Nature 521 (2015) 436-444.