Combined Laser Scanning Confocal Microscopy and Reflected White Light Microscopy as a Technique for Measuring the Leakage Produced by Nb_3Sn Cable Damage

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Introduction

A recently acquired laser scanning confocal microscope has provided us with a capability for accurate non-contact volumetric and topographic measurements of a variety of samples, the results of which are integral to other reported activities. In addition to the high resolution (down to 0.17 µm) monochromatic images obtained using the violet scanning laser, the system also can acquire a color image using a white light LED source of highly consistent spectral uniformity. Here we report how combining this capability with improved sample preparation facilities is providing new insights into Nb_3Sn Rutherford cable degradation.

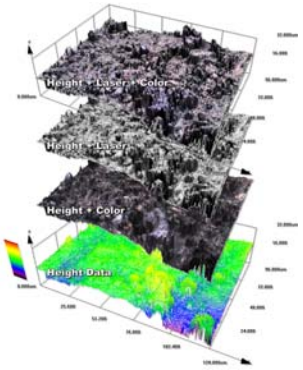

Figure 1. In this example we show how the topological, laser and white light images from the OLS3100 LSCM can be combined to show that the different phases in this fractured Fe-oxypnictide sample.

Experimental

In Figure 1 we show how the three distinct data-sets generated by the OLS3100 LSCM can be combined to provide a detailed surface reconstruction of a sample (in this case on of the new Fe-oxypnictide superconductors discovered in 2008. The topmost "height+laser+color" combines the high spatial resolution monochromatic image with the lower resolution color information, without losing resolution, by restricting all the luminosity information to the laser-generated image component. The LSCM system also incorporates a digital stage that can automatically assemble images that cover a large area at high magnification by scanning a matrix of adjacent areas and assembling them by image matching.

Results and Discussion

Figure 2. Shows an example of LSCM use for understanding cable degradation in Nb_3Sn strand applications. The digital stage allows us to assemble a high resolution color image of the entire cable cross-section and the excellent color uniformity shows where Sn has leaked into the surrounding stabilizing Cu.

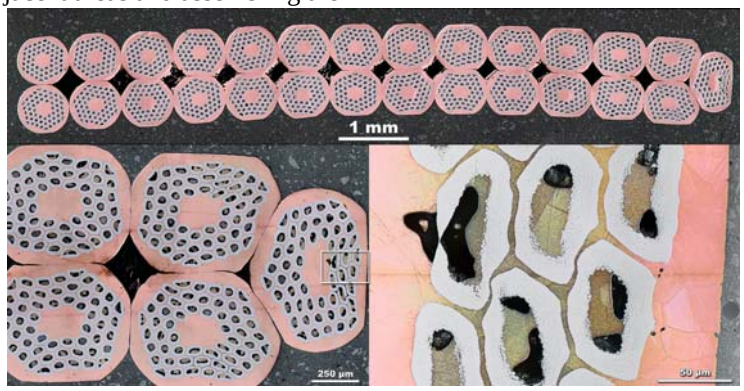

Figure 2. In this Nb_3Sn example, the digital stage allows us to expand our field of view to cover an entire Rutherford cable and also look in detail at Sn distributions on the sub-element level. In this sample, cabled at LBNL and heat treated at BNL, sub-elements in the end strand have been ruptured and Sn has leaked into the Cu stabilizer (green tint) but the leakage has been restricted to the sub-element vicinity resulting in fully reacted sub-elements.

Conclusions

LSCM combined with color imaging and modern metallographic techniques can be combined to provide a better understanding of engineering quality superconductors.

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