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Automatic Detection of Local Obstacles in a Long Length RE-123 Coated Conductor by Deep Learning Based Image Classification in Reel-to-Reel Magnetic Microscopy

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We have succeeded in detecting local obstacles automatically in a 200-m-long RE-123 coated conductor (CC) by introducing deep learning based image recognition in reel-to-reel scanning Hall probe microscopy (RTR-SHPM). Longitudinal Ic homogeneity in CCs is one of the most important requirements for practical applications. Usually, such properties as Ic variation as a function of longitudinal coordinate is characterized by magnetization measurements adopting Hall probe array as a de facto standard characterization method for ensuring uniformity in long CCs. In this measurement, local Ic drop indicates the existence of current blocking obstacles. The group of authors also developed a magnetic microscopy applicable to reel-to-reel continuous measurements, RTR-SHPM, which makes it possible to visualize two dimensional magnetization current in the tape plane because of its high resolution imaging along the tape width. As a result, more elaborate defect detection is enabled. However, in the conventional technique, the observation depends on the human eye, therefore, there was a limit to analyse the magnetic image extending to thousands of images in the long tape of several 100 of meters. In this study, the image analysis based on the deep learning was introduced in our magnetic microscopy. The analytical model classifies the input image into the defect position and the normal position, respectively, together with a heat map and a score of confidence in the recognition. As a result, we have succeeded in detecting obstacles automatically from more than 4,000 of magnetic images. Furthermore, we revealed the existence of the obstacles which are not distinguishable by the local Ic criterion. This method allows us to clarify the origin of the instability of long CC wire and will have a strong impact as an evaluation technique for dramatically improving the reliability of the CCs.
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