

# Machine Learning Approach on Steel Microstructure Classification

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## Abstract

The microstructure of a material is its inner morphological features. The microstructure of steel can be diverse and complex depending on the composition, heat treatment, and processing of the alloy, making it difficult to accurately predict the material's property and composition without physically analyzing the microstructure. Since the microstructure of steel can determine its physical and chemical properties as well as its performance, cost, and efficiency, it is absolutely crucial to accurately classify the microstructure. The importance of correct analyzation of microstructure can be seen in the example of SS Schenectady in WW2. When the ship was exposed to frigid waters, the ship split in half as it underwent a ductile to brittle transition, which depends on the composition and microstructure of the material. Although microstructure characterization is widespread and well known, it is mostly done manually by human experts analyzing pictures taken by either scanning electron microscope or light optical microscope.

This project aims to automate this processing using state-of-the-art Machine Learning architectures and models to train and learn to differentiate, classify, and interpret the microstructure pictures, employing a pixel-wise segmentation method, most commonly known in its use in self-driving cars, via U-NET architecture built upon FCNN, Fully Convolutional Neural Network. The method employed several high-end techniques ranging from data augmentation, Amazon computing service, to semantic segmentation. The system achieved high classification accuracy and predicted the mechanical property with minimal error, providing a robust, accurate approach for the difficult task of microstructure classification.

**Keywords:** *Machine Learning, Pearlite, Ferrite, U-NET, Convolutional Neural Network*

## References

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## Biography

Abdullah Öztürk is a Professor in the Department of Metallurgical and Materials Engineering of Middle East Technical University. He received the B.S. from Istanbul University in 1983. He received his M.S. and Ph.D. from University of Missouri-Rolla in 1987 and 1991, respectively. His major research areas are on synthesis of nano materials and microstructural/surficial characterizations of the functional materials.