

# **MICROSTRUCTURE ANALYSIS OF FERROMANGANESE LUMPS USING IMAGE PROCESSING**

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**Abstract:** Digital image processing is the technique to process pixel variations on digital images. This paper employs the digital image processing procedure for microstructure analysis of ferromanganese iron ore using matlab. The ferromanganese iron ore samples are collected from the industry m/s ashirwad minerals and metal industry. The images of the samples were taken in an appropriate environment and processed. Some of processing steps as pre-processing, thresholding, filtering process, are done on these images for effective and detailed study of ferromanganese iron ore. Then the samples are classified into low carbon or high carbon ferromanganese.

**Keywords:** filtering ,Histogram equalization, thresholding

## **I. INTRODUCTION**

Ferromanganese is composed of carbon, manganese, silicon, phosphorous, nitrogen, sulphur and iron it is impeccable chemical composition free from impurities corrosion proof fine anti-oxidant characteristics low melting point sturdiness hence it is used in stainless steel, heat resistant steel and electric welding electrodes.

In traditional method the exposed x-ray film is immersed in developing solutions. For about 10sec and then removed and observed in safe light. From the literature survey we see that most of the research has been carried out on the microstructure analysis of different materials like limestone, castiron, steel etc. But microstructure analysis of ferromanganese is not focused at all. Sharmila M. Mukhopadhyay in her paper sample preparation for microscopic and spectroscopic characterization of solid surfaces and films mentioned how to preprocess the sample before taking the image. Sample is first cut in desired shape, then that sample is mounted and rough polishing is

done. Sample is cleaned with particular chemical solution (acetone followed by ethanol). Etching is done on cleaned sample so as the lowest energy surface gets enhanced. Anagha mirashi uses canny edge detection algorithm which first smooths the image and then highlights regions with higher spatial derivatives. Artificial neural network is trained to classify flake type. In paper artificial intelligent metallurgical grain detection presented by Adarsh Kesireddy train neural network to recognize the phase of steel using six features (entropy, energy, contrast homogeneity, number of peaks in the histogram, and percentage of black pixels in the binary version of the image). Different linear and nonlinear filters were examined for better removal of noise such as mean or median filter.

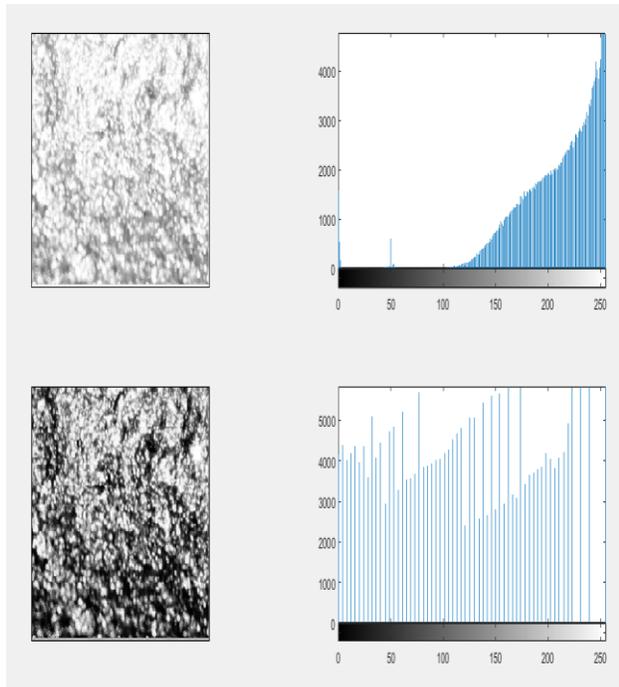
## **2. Experiment:**

First the sample is cut in required dimension using EDM wire cutting machine. For etching sample's surface is rubbed by emery paper. Emery paper grades are 80,220,500 in same order, then till mirror finishing cloth polishing is done on sample, then the image is captured using optical microscope.

## **3. Histogram equalization:**

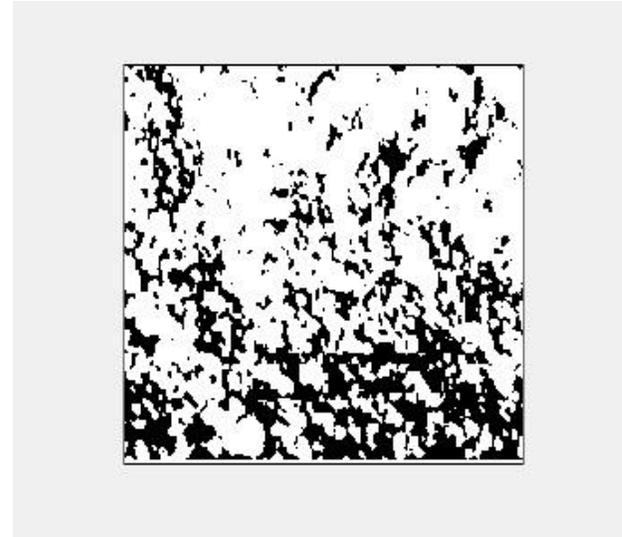
The sample was having two-phase structure which is also observed. The ferrite in the sample appears bright and pearlite in the sample appears dark. Grains of ferrite phase are polygonal and equiaxed. Pearlite however is unresolved. Contrast and signal-to-noise ratio in the raw image are poor. Histogram of the raw image is shown which shows that intensities of the pixels are in the range of 30-195 (on the gray scale range of 0 to 255) which leads to poor contrast in the image. A three stage filtering scheme has been investigated to process and analyse the metallograph. In the first stage histogram equalization is

implemented. The histogram equalization rescales the range of an image's pixel intensity values to produce an enhanced image whose pixel intensity values are more uniformly distributed. The enhanced image tends to higher contrast.



#### 4. Thresholding:

Thresholding is implemented. It allows segmentation of pixels in image into multilevel classes. The filtered image is the source image for thresholding. Low carbon ferromanganese has two phase structure (ferrite and pearlite). We have used two level thresholding which divide the intensity value set into two non-overlapping ranges, each of which can be associated with a unique value in the resulting image. It is helpful in automatic evaluation of percentage volume of ferrite in the image.



#### 5. Results:

Following the above filtering scheme, we have applied histogram equalization on 0-255 which was taken as a threshold value. Care has to be taken in selecting the threshold in a way so that any part of the grain boundaries does not vanish. All the pixels in the image having intensity less than or equal to 59 have been replaced by the intensity value 0. Pixels having intensity values 60 or above have been replaced by intensity 255. If we consider the whole image it appears that this threshold value is very close to the sum of the minimum intensity and the standard deviation of the intensity in the image. Histogram is shown in which clearly shows that now there are only two intensity values 0 and 255 i.e. dark and white respectively. Percentage of white pixels in the image i.e. ferrite was obtained as 70.40%. One more area of the specimen was focused for acquiring image and processed in the similar fashion with the same threshold value. The ferrite in this zone comes to be 71.56%. It was due to the reason that the grain boundary and grain size was not exactly same in both the vicinities. The algorithm for processing and analyzing the image was developed in matlab environment. Implementing histogram equalization and thresholding for verification of the results, carbon percentage by weight in the sample was determined. Average carbon in the test sample was obtained as 0.2537% by weight. From iron carbon equilibrium diagram of ferromanganese, at room temperature, the maximum ferrite (100%) is present at 0.025% of carbon and maximum pearlite (100%) is

present at 0.8% of carbon by weight, using lever rule. The ferrite comes to be 70.49% in the ferromanganese having 0.2537% carbon. The results obtained from processed metallographic image and are in good agreement. Average variation in result from processed metallographic image is approximately 1%. Variation in result may be due to excessive lighting in certain zone of the image while its acquisition and the assumption that the 2d image (i.e. cross section of the volume) is representative of the 3d sample.

### Conclusion:

The image processing technique based on histogram equalization followed by thresholding is very effective in enhancing contrast of the recorded metallographic image and analysis from it. For the threshold value in the range of 0-59 and 60-255 as 0 and 255 respectively, the fraction of bright area in the image is 70.40%. It implies that the volume of ferrite in the specified zone of the sample is 70.40% at the above mentioned threshold. Selection of proper threshold plays an important role in extracting the required information from the image quantitatively. Average variation in result from processed metallographic image and is less than 1%. The algorithm developed makes the phase determination system simple and cost effective. Early investigations establish that analysis of constituents in different zones of welding is also possible by the algorithm presented in the paper.

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