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GRAIN BOUNDARY DETECTION OF THE CRYSTALS USING CANNY EDGE DETECTION

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ABSTRACT
Microstructure of the materials is characterized by employing Scanning Electron Microscope (SEM). Image processing algorithm is implemented to detect the grain boundary of the crystal using SEM images. For this Canny edge detection is used to segment the boundaries of the crystal. In this method of edge detection the grain boundary estimation of the crystal estimation is quite high.

KEYWORDS: Crystals, Grain boundary, canny edge detection, SEM images, Image processing

INTRODUCTION

The structure of crystalline solid, whatever is its dimension, can be characterized by several means such as X-ray diffraction and microscopy, for micro- and nonmaterial's, use of electron microscopy is necessary. In the case of SEM images crystallographic information such as grain boundary, stain, and dislocation are revealed from poly crystalline specimens. Digital images acquired in a SEM, by the secondary electron imaging (SEI) or backscattered electron imaging (BEI) mode have suitable quality and resolution for further image processing and analysis [1]. Grain boundary is the interference between the two adjacent crystalline domains. The study of the structure and energetic of grain boundaries in metallic and ionic crystals are well developed. (Sass 1986). The identification of grain boundaries makes it possible to make quantitative measurements such as those of grain size and shape which can be used to address a wide variety of geological problems (Futen *et.al* 1998). The properties of polycrystalline materials are often dominated by the size of their grains and by the atomic structure of their grain boundaries. These effects should be especially pronounced in two-dimensional materials, where even a line defect can divide and disrupt a crystal (Chang *et.al,* 2011). The importance of grain boundary in the organic FET's for mobility of the charges was studied (R.T.Weitz *et.al)*. The study of the grain boundary plays the important role in crystal studies. Using image processing technique, edge detection is used for detecting the boundaries of the crystals. It is a process which is used to capture the significant properties like discontinuities in the geometrical, photometrical and physical characteristics of an object in that grey level image. In early methods of edge detection involve convoluting the image with a 2D-filter operator. The geometry of the operator determines the characteristic of orientation in which it is sensitive to crystal edges. Operators can be optimized to look for horizontal, vertical, and diagonal edges of the crystal. Edges are generally detected using gradient techniques such as Sobel, Prewitt, Roberts, Laplace of Gaussian and Canny operators [2-3]. This gives the optimized solution for edge searching problem [4]. This paper deals with SEM images by the secondary electron imaging for detecting the edges of the grain boundaries in crystal.

MATERIALS AND METHOD

Image processing techniques for finding the grain boundary consist of Image Acquisition, Image Enhancement, Image Segmentation, Feature extraction. The below block diagram shows the proposed approach.

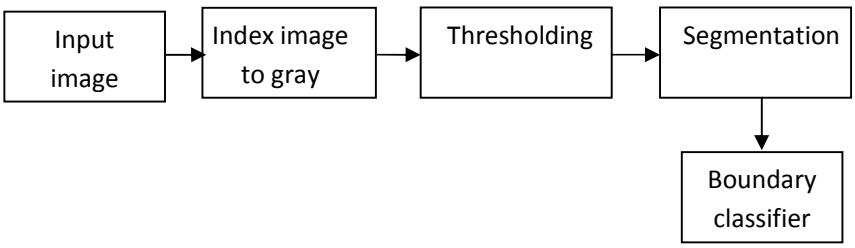

FIGURE 1. Block diagram of the proposed approach

The crystals were analyzed and examined using Scanning Electron microscopy. An SEM generates high energy electrons and focuses them on a specimen. The crystals were subjected to secondary electron imaging in SEM

produces vivid images with good resolution 1-5µm [5]. The images from the SEM are in indexed mode [6] so that these images should be converted to gray scale mode. The process of conversion of a gray scale image into a binary is called thresholding. In a binary image, object pixels are represented by 1s or the highest intensity possible in the image (255 in an 8-bit image) and background pixels are denoted by 0s. This type of representation retains all the structural properties of the image but loses color and texture information. The binary image obtained is usually noisy; hence, a filtering step is required for cleaning the image for further processing. SEM images are noisy by nature due to the statistical nature of electron collision and emission as well as the final detection system [7]. After thresholding, the binary image obtained still contains some noise; hence, a 2-D adaptive wiener filter is applied to improve the performance of the subsequent steps.

EDGE DETECTION

The Canny edge operator takes the grayscale image as input and calculates the gradient of intensities, a vector with both magnitude and direction. It is applied to find both the strong and weak edges of each particle. The normal of the edge aligns with the direction of the gradient vector, and the magnitude gives the strength of the edge. Canny edge detection uses linear filtering with a Gaussian kernel to smooth noise and then computes the edge strength and direction for each pixel in the smoothed image. This is done by differentiating the image in two orthogonal directions and computing the gradient magnitude as the root sum of squares of the derivatives. The gradient direction is computed using the arctangent of the ratio of the derivatives. Edge pixels are identified as the pixels that survive a thinning process called non-maximal suppression. In this process, the edge strength of each edge pixel is set to zero if its edge strength is not larger than the edge strength of the two adjacent pixels in the gradient direction [8].

ALGORITHM

1. Smooth the image by convolving with a Gaussian of variance σ^2.
2. Compute the gradient of the smoothed image, and compute its magnitude and direction.
3. Non-maximal suppression: Select the pixels where the gradient magnitude has a local maximum in the direction of the gradient
4. Using two specified thresholds, T1 and T2, with T1 <T2, mark selected pixels with gradient magnitude larger than T2 as 'strong', and pixels with magnitude between T1 and T2 as 'weak'.
5. Select all strong pixels, and all weak pixels that are connected to strong pixels horizontally, vertically or diagonally.

EXPERIMENTAL WORK

The organo-inorganic crystal has been grown from solution by slow evaporation method at ambient temperature. The grain boundaries of the alkaline crystals like AKBr, ALiI, ANaBr, and ANaI are studied using image processing.

SETTINGS

Those crystals are subjected to Secondary electron imaging in scanning electron microscopy under 5keV beam energy at a working distance of 500µm. The SEM is saved as graphic file format for further process in MATLAB environment. The image acquisition is done by using *'imread'* MATLAB command and it is converted into intensity to gray image. Thesholding is taken by converting the gray image into binary image. 2D adaptive filter is introduced to reduce the noise in the SEM images. And this filtered image is further processed by introducing canny edge detection.

RESULTS

We apply our method to SEM images. Our intention is to find the grain boundaries of the crystals. Figure (1a) shows the graphics format of the SEM image and figure (1b) shows the filtered image of the alkaline crystals.

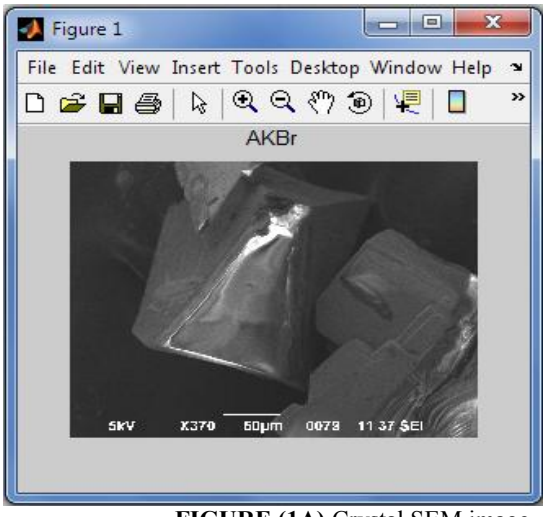

FIGURE (1A) Crystal SEM image

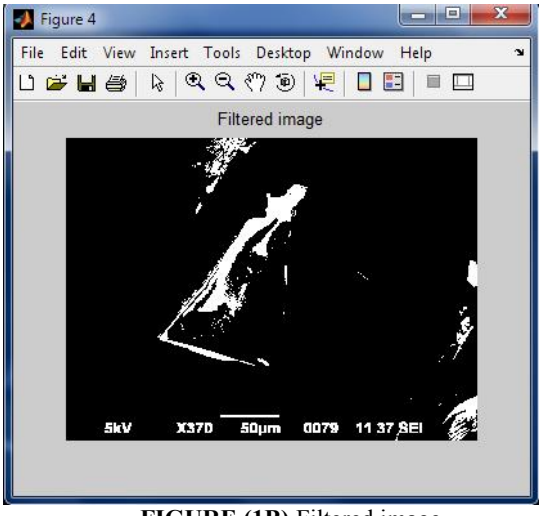

FIGURE (1B) Filtered image

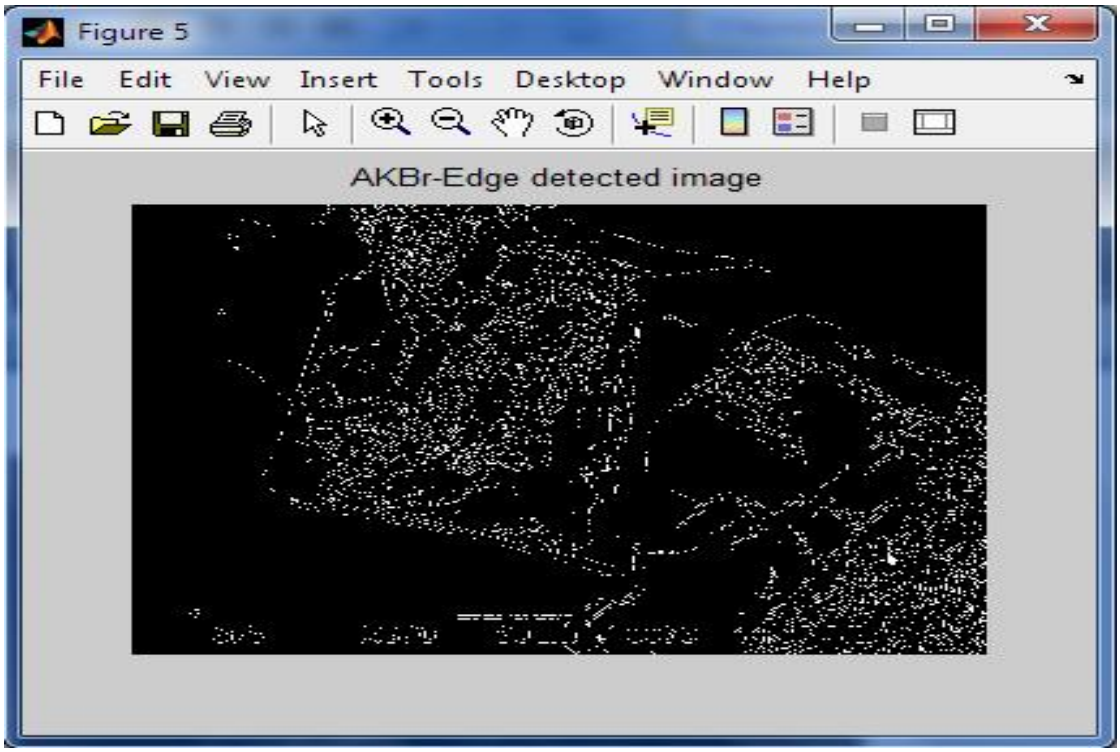

FIGURE (2A) shows the edge detected image of the crystals.

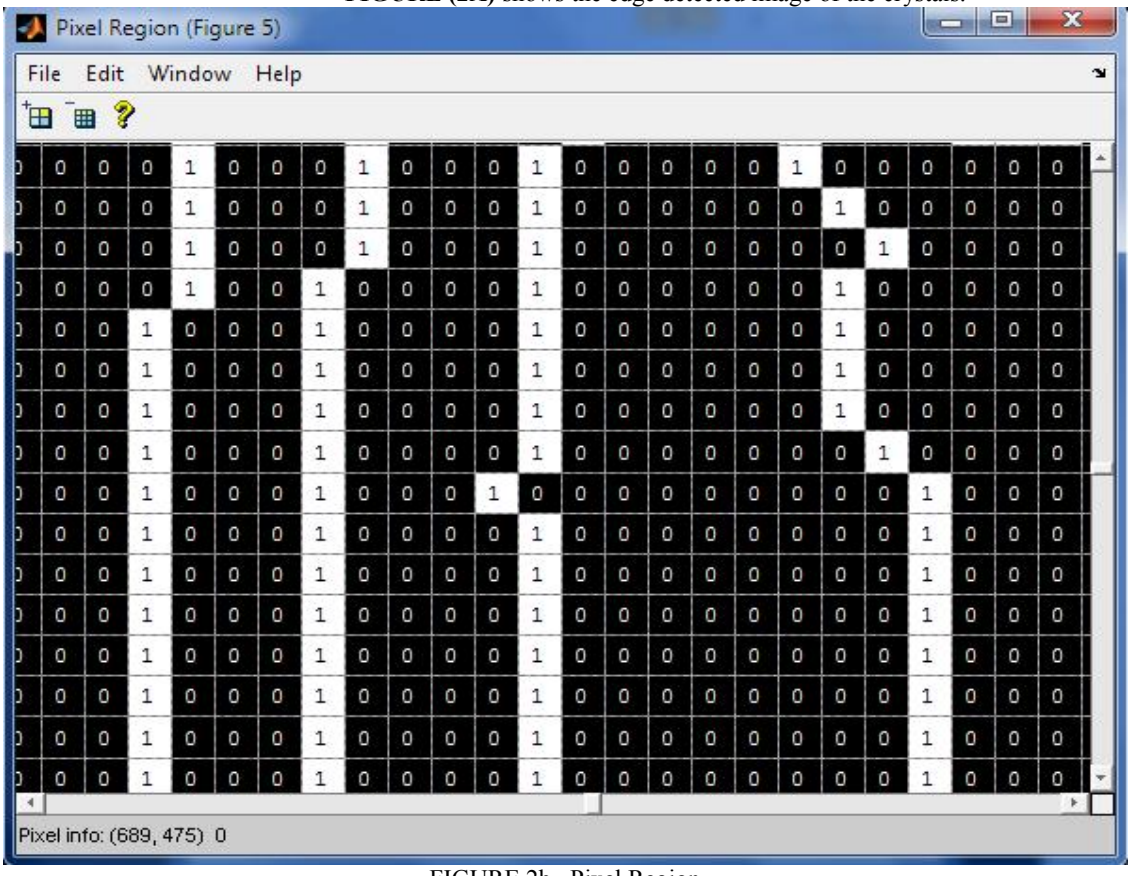

FIGURE 2b. Pixel Region

Figure (2a) and (2b) shows the edge detected image and corresponding pixel region of the crystals. After filtering the image those images are subjected to edge detected image shows the pixel regions of the grain boundary crystal as ones. The grain boundary ranges from 120 µm to 185µm for AKBr crystal. For ALiI the range of the grain

boundary is 260 to 606 μm. ANaBr and ANaI grain boundary lies between 188 to 359 μm and 286 to957 μm respectively.
From this results the grain boundary of the alkaline crystals are found using canny edge detection.

CONCLUSION

The organo-inorganic crystal microstructure plays vital role in polycrystalline films, organic electronics field and ceramic materials. The grain boundaries of the alkaline crystals determine the formation and growth of the crystals. In that case detecting the boundaries is very important in crystals. Canny detection is used in this paper to find the regions of the grain boundaries in the alkaline crystals.

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