

Introduction

Fine (or Micronized) rubber powder is the by-product of crushed tires resulting from the recycling of a mixture of used tires of various categories. The composition of the scrap tires is usually a mixture of two types of synthetic rubber (SBR and NBR) and natural rubber, carbonaceous steel, and fibers such as nylon, polyester and rayon. A machine first crushes the tires, and then separates the steel scraps to make a fine rubber powder under airtight conditions.



Fine rubber powder has multiple uses. From fill material in roadbed and embankment stabilization projects, it can also be mixed in with asphalt for pavement. The use of fine rubber powder in molded goods like rubber mats, paving stones, and automotive parts is a testament to recycling, as is its use in golf courses and sports fields to protect turf and provide better drainage.

Sample Description

Two samples of micronized rubber powder were submitted for image analysis. A small quantity of particles was withdrawn from each sample and dispersed on a slide for analysis suitability.

Purpose of Analysis

To demonstrate that the Clemex Vision image analysis system can discriminate the rubber particles and perform size and shape measurements on them.

Procedure

A Guard Frame was used to avoid measuring incomplete features that are sectioned by the field of view. After an automated light adjustment, particles were binarized into the blue bitplane using Gray Threshold. A clean-up was done to eliminate small particles of 3 x 3 pixels or less. Connected particles were separated prior to measurements.

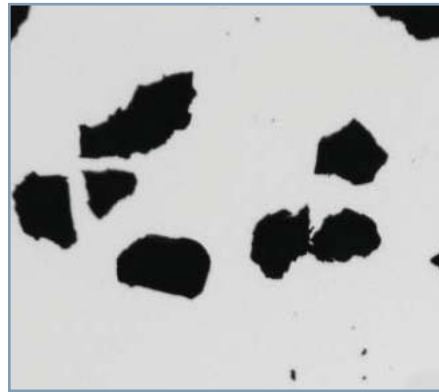


Figure 1: Part of the original image as captured using a Leica stereoscope (4.8376 microns/pixel).

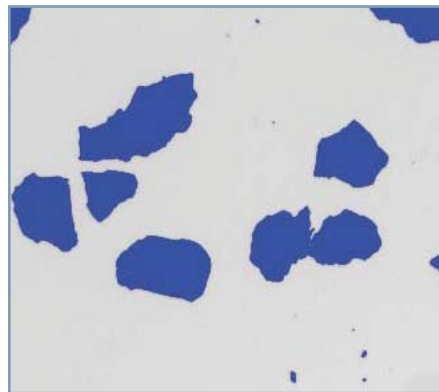


Figure 2: Particles are binarized into the blue bitplane using Gray Thresholding tool.

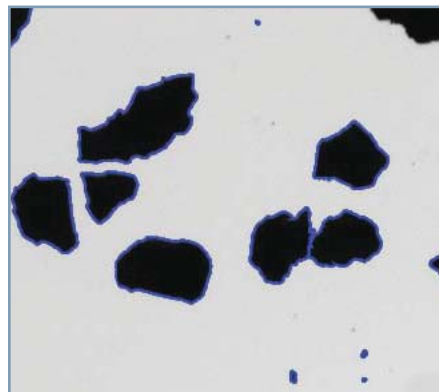


Figure 3: Outline of particles as measured in blue bitplane. Small particles (3 x 3 pixels or less) were eliminated, connected ones were separated and only complete ones were measured.

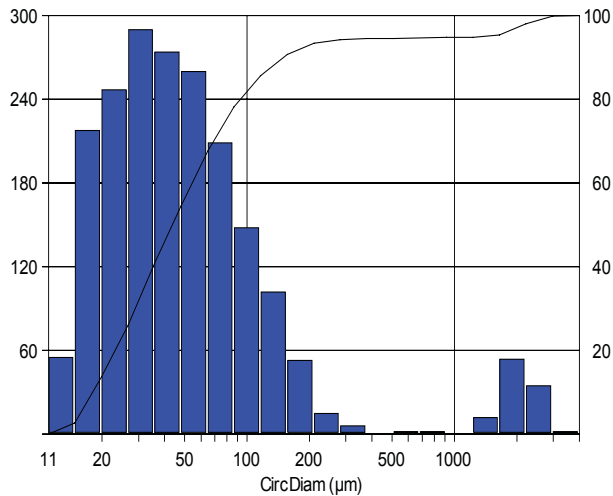
Results

Area, Length, Width, Feret Average, Circular Diameter, Sphericity Roundness, Aspect Ratio, Compactness and Roughness measurements were performed on each feature. Automated statistics and graphs were generated and printed in pdf format. Final results can be saved from Clemex Vision and loaded back for further use. A customized report was built using the Report

Generator module. Raw data is linked to their respective objects for validation purposes. Raw data were also exported in Excel format.

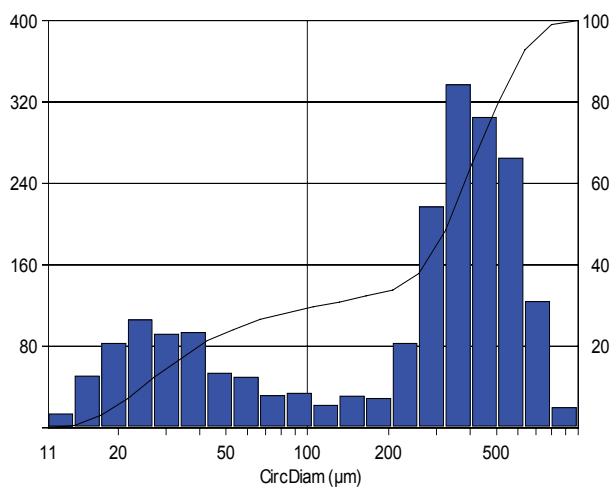
D90: 604.12 microns

Figure 5: Particles' circular diameter distribution and corresponding statistics - Sample 2



Count: 1985
 Minimum: 10.92 microns
 Maximum: 3116.50 microns
 Mean: 163.92 microns
 Std Dev.: 467.90 microns
 D10: 18.00 microns
 D50: 43.94 microns
 D90: 147.08 microns

Figure 4: Particles' circular diameter distribution and corresponding statistics - Sample 1



Count: 2043
 Minimum: 10.92 microns
 Maximum: 967.98 microns
 Mean: 310.73 microns
 Std Dev.: 220.54 microns
 D10: 24.26 microns
 D50: 330.19 microns

Equipment

Image Analysis System: Clemex Vision PS3
 Microscope: Leica Z6
 Illumination: Reflected Light
 Calibration: 4.8376 microns/pixel
 Camera: Clemex L 2.1M (1608 x 1212)
 Motorized Stage: Marzhauser EK321M 75x50mm
 Stage Controller: Clemex ST-2000

Discussion

The main difficulty in this analysis was to detect small and large particles without sectioning the large ones or measuring a cluster as a unique large feature.

A stereoscope was used allowing us to see the largest features while still seeing small ones. The use of a guard frame allowed us to consider only complete features.

In both samples, two size distributions were observed. Sample One was composed of some very large particles mixed with a large quantity of very small ones. Sample Two also presented two distributions but with a smaller variation between both. The results were printed out in two versions: one with all particles together and one including only the largest distribution (for Length and Diameter only). In the latter case, the old statistics (for all particles) appear in parenthesis for comparison purpose. If desired, the small distribution can be automatically excluded from the analysis.

Results are reproducible.