APPLICATION NOTE

# IMAGE ANALYSIS OF CERAMIC POWDER CATALYST

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Fluidized ceramic powder catalysts are important ingredients in the cracking process by which the complex organic molecules in petroleum are broken down into simpler molecules by the shattering of carbon-carbon bonds. In Fluid Catalytic Cracking, the long-chain molecules of high-boiling hydrocarbon liquids are turned into much shorter molecular chains at elevated temperature by means of a fluidized powdered catalyst.

The powdered catalyst usually consists of small ceramic balls, or beads, about one to two microns in diameter. These beads, packed in columns, draw out impurities from crude oil as it passes through. During this process, the beads wear down and lose their properties as catalysts due to a reduction of surface area.

Clemex was provided with four vials containing ceramic beads. The purpose of the analysis was to see if the software could classify a group of beads by degree of wear. The vials were numbered:

- Vial #1 contained pristine beads;
- Vial #2 contained slightly worn beads;
- Vial #3 contained worn beads; and
- Vial #4 contained fragmented beads.

**Analysis process**

The beads were randomly placed onto a sticky surface to prevent them from moving around. If a large number of samples were to be analyzed, a grid to hold the samples in place should be considered. The motorized stage's movement would thus always be the same.

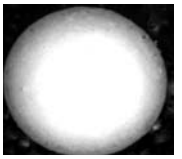
Given the size of the beads (± 2 µm), a low-power objective is needed, to keep them entirely within the visible area (as much as possible). Nevertheless, the magnification must be sufficiently high to resolve the texture of the ball surface. A magnification of 50X was found to be the best compromise for this analysis.

Considering the shape of the beads and the magnification, it is possible to focus only on small sections of an object at the same time. The Multi-Layer Grab software instruction is thus vital in reconstructing the complete image from the several images taken at different Z positions, each with only a small area in focus. The Z displacement of the motorized stage was doubled to increase the speed of the Multi-Layer Grab instruction.

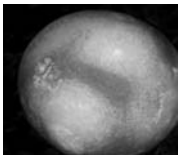
It was found that reflected light and a black background are the best conditions for the best contrast of surface details, and thus to see the greatest variation in gray levels from one category to another.

Via the analyzer, a number of different factors were measured on beads belonging to each of the four categories. These factors are size, gray intensity, and texture. Although none of these three factors alone is enough to categorize the beads according to the four wear levels, their combined use makes classification possible. The results were compared on graphs, and those that showed a clear-cut variation between categories were retained.

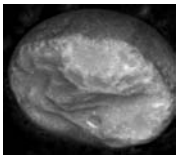
To see a video showing an analysis in action, visit www.clemex.com/Multimedia/PS3/PS3.html.



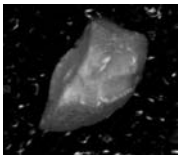
*Vial #1: pristine beads.*



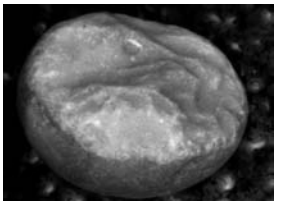
*Vial #2: slightly worn beads.*



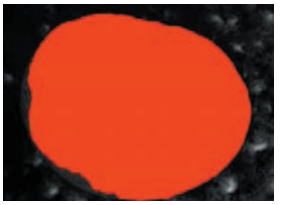
*Vial #3: worn beads.*



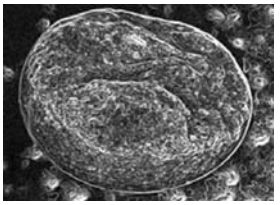
*Vial #4: fragmented beads.*



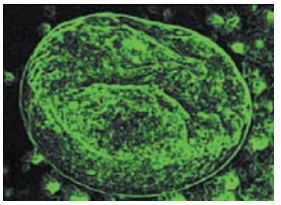
*Reconstructed image of the worn beads using the Multi-Layer Grab instruction.*



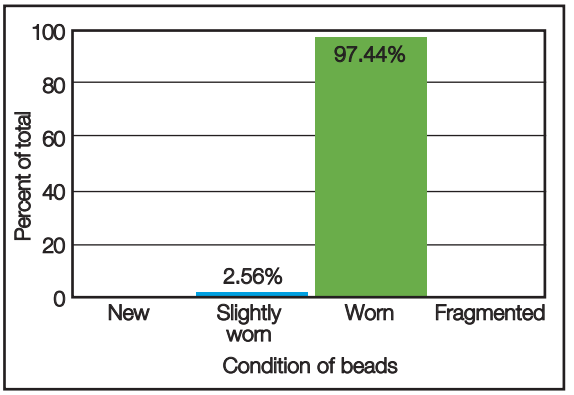
*Red: Thresholding of the worn bead.*



*Kirsh Transformation of the original image to make the bead's texture visible.*



*Green: Thresholding of the textured areas that correspond to wear.*




*For a group of beads, the Clemex Vision image analysis system can automatically calculate the percentage of each of the four categories to which they belong. From there, the final classification is easily done.*

Microscopy combined with image analysis is increasingly being recognized as the most reliable technique to characterize particle shape, as well as particle size and volume distribution. Methods such as laser diffraction, although highly efficient, give limited information on particle shape, showing that image analysis is the best tool for particle analysis.

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