

# Metkon Application Note

Grain size analysis of steel wire

## INDEX

1. INTRODUCTION
2. APPLICATION REQUIREMENTS
3. SAMPLE PREPARATION PROCESSES
4. RESULT

Requested samples are steel wire which they used for horse shoe nail.



In this application note, samples prepared for grain size analysis.



## A- CUTTING



MICRACUT 201 is built on precisely manufactured heavy duty aluminum frame providing stable and vibration resistant base for precision components and linear bearings.

The cutting compartment is fully enclosed.

The transparent hood is equipped with interlocking safety switch. Powerful cutting motor has variable cut-off wheel speeds from 400 up to 5000 rpm allowing both high speed and low speed cutting.

By moving the cutting table, MICRACUT 201 can cut larger and deeper samples. Wide range of clamping tools can be used on the T-slotted moving table. Optional X - axis table with motorized drive mechanism positions the specimen with 5 microns positioning accuracy.

|                        | Order Code | Description                                |
|------------------------|------------|--------------------------------------------|
| <b>Equipment Used</b>  | 17 06      | MICRACUT 201, PRECISION CUTTER             |
| <b>Clamping Device</b> | GR 0548    | Quick acting clamping vice assembly        |
| <b>Cutting Fluid</b>   | 19-902     | Metcool, Nature Friendly Soluble Oil, 5lt. |
| <b>Cutting Disc</b>    | 19-200     | DIMOS Ø 200 mm, Diamond cutting disc       |

## B- HOT MOUNTING



ECOPRESS 100/200 are high capacity, state of the art automatic mounting presses having advanced software with programmable HMI touch screen controls. Robust bayonet closure allows for quick and safe operation. Wide selection of mould assemblies from 25 to 50 mm in diameter is available.

Two mounts can be produced simultaneously with the use of an intermediate ram. ECOPRESS 200, available with dual cylinder can produce four mounts at a time offering a perfect solution for labs with high specimen throughput.

|                        | Order Code | Description                                 |
|------------------------|------------|---------------------------------------------|
| <b>Equipment Used</b>  | 25 07      | ECOPRESS 100 mounting press                 |
| <b>Clamping Device</b> | 26 06-02   | Mould Assembly, 40 mm with intermediate ram |

### C- GRINDING & POLISHING



DIGIPREP preparation systems are designed for fully automated materialographic sample preparation for consistent and reproducible specimen quality.

DIGIPREP's Automatic Head controls the force applied precisely and specimens are prepared exactly the same way every time, independent of operator skills. With the ability to store and recall preparation programs on the LCD screen, same consistent results are obtained.

Efficiency is further increased by adding DOSIMAT Peristaltic Dispensing Unit for automation and control of consumable consumption.

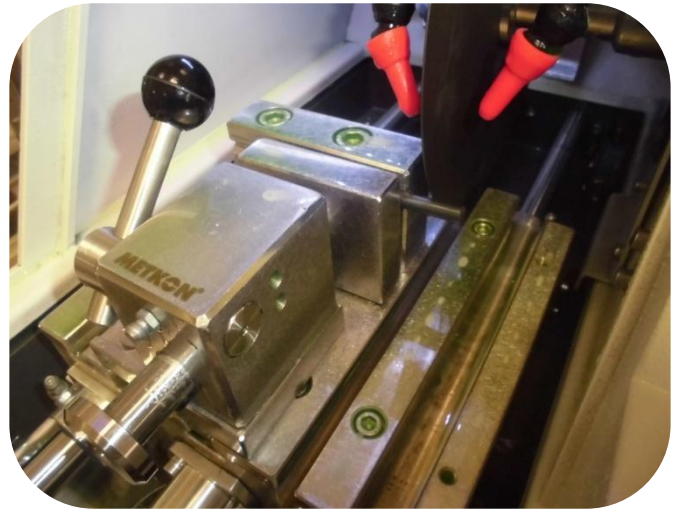
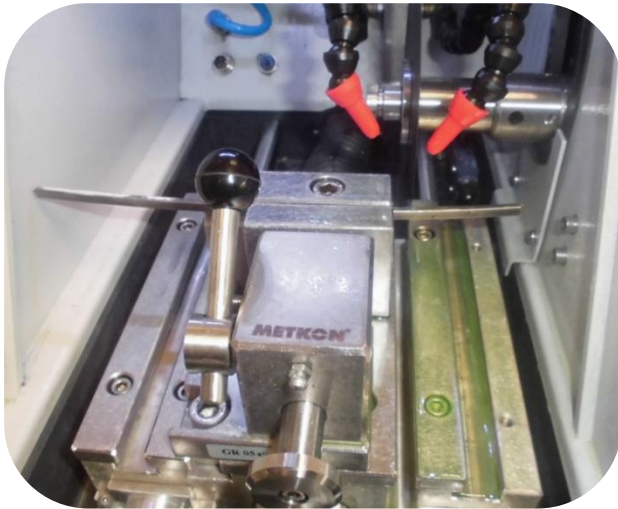
|                | Order Code | Description                              |
|----------------|------------|------------------------------------------|
| Equipment Used | 45 03      | DIGIPREP 251                             |
| Accessories    | 31 22      | Aluminium wheel, 250 mm for DIGIPREP 251 |
|                | 31 63      | Splash Guard, 250 mm for DIGIPREP 251    |
|                | 39-003-250 | SMF, Ø 250 mm, Special Magnetic Foil     |
|                | 39-093-250 | TMP, Ø 250 mm, Thin Metal Plate(5 pcs)   |
| Sample holder  | 45 13      | Ø 130 mm, Clamp Type, 4 x Ø40 mm.        |
|                | 45 10      | Specimen Loading Plate Ø130 mm.          |

### D- MICROSCOPY



BasicMagnifications : 100x - 1000x  
 Eyepieces : WF 10x eyepieces paired (field of view Ø16mm)  
 Objectives : 10x/0.25 (W.D. 6.7mm), 25x/0.40 (W.D. 0.76mm)  
 40x/0.65 (W.D. 0.67mm), 100x/0.25 (oil) (W.D. 0.3mm)  
 Stage : Mechanical stage 200 x 152mm travel with right hand  
 Coaxial dropdown controls, movable range 15 x 15mm  
 Focusing : Coaxial low position coarse & fine focus controls  
 graduated to 2 microns per division.  
 Illumination : 6V 20W adjustable light sources with halogen lamp  
 Size&Weight : 540L x 195W x 320H mm & 10kg  
 Order No : 60 01

|                | Order Code | Description                                            |
|----------------|------------|--------------------------------------------------------|
| Equipment Used | 60 01      | IMM 901, Trinocular Inverted Metallurgical Microscope. |
|                | 66 10      | IMAGIN Hardware Set                                    |
| Software       | 66 02      | IMAGIN MESURA 200                                      |
|                | 66 04      | IMAGIN GRANO 200                                       |
|                |            |                                                        |



Samples are attached as it shown in the above photos with the GR 0548 vise.

Operation parameters are following;

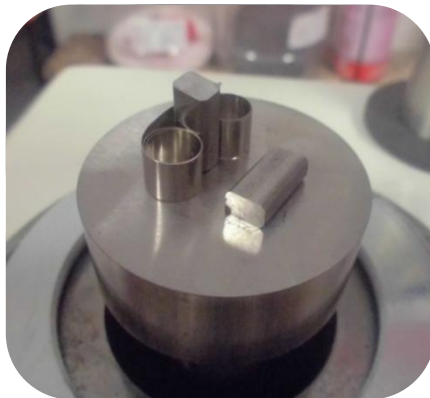
Table feed-rate: **250  $\mu$  / sec.**

Disc speed: **2500 rpm**

Travel: **25 mm**

Force: **3A**

**With these parameters cutting cycle took 2-3 min per sample.**



After cutting operation small pieces mounted with ECOPRESS 100 mounting machine. Acrylic based powder (NET) used for mounting operation.



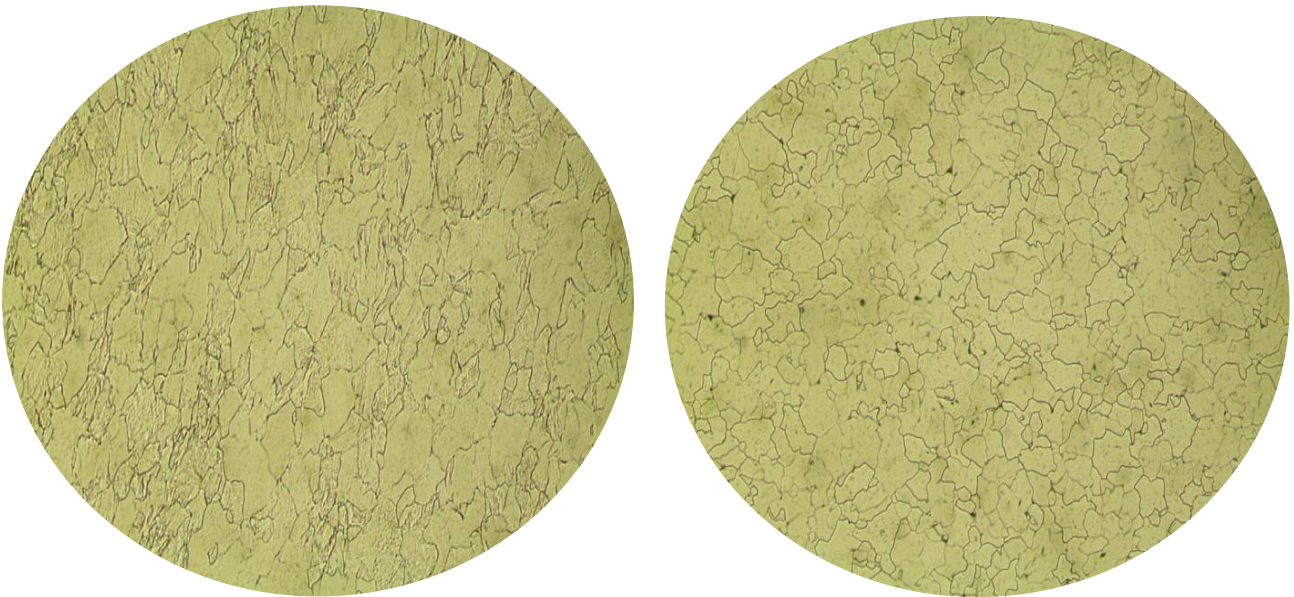
Grinding & polishing operation made with DIGIPREP 251. The operation parameters and consumable list are following.

|                        | <i>Surface</i>           | <i>Abrasive</i>                | <i>Lubricant</i>   | <i>Force per sample (N)</i> | <i>Time (min.)</i> | <i>Disk speed(rpm)</i> | <i>Head speed(rpm)</i> |
|------------------------|--------------------------|--------------------------------|--------------------|-----------------------------|--------------------|------------------------|------------------------|
| <b>Grind. Step 1</b>   | DEMPAX<br>[38-040-600]   | 600 grit<br>SiC                | Water              | 20 N                        | 1 min.             | 200                    | 100                    |
| <b>Grind. Step 2</b>   | DEMPAX<br>[38-040-1000]  | 1000 grit<br>SiC               | Water              | 25 N                        | 2 min.             | 200                    | 100                    |
| <b>Grind. Step 3</b>   | DEMPAX<br>[38-040-2000]  | 2000 grit<br>SiC               | Water              | 25N                         | 2 min.             | 250                    | 100                    |
| <b>Polish. Step 1</b>  | METAPO-B<br>[39-033-250] | DIAPAT-M 3 $\mu$<br>[39-420-M] | DIAPAT<br>[39-502] | 25 N                        | 3 min.             | 150                    | 75                     |
| <b>Polish. Step 1</b>  | FEDO-1<br>[39-065-250]   | DIAPAT-M 1 $\mu$<br>[39-410-M] | DIAPAT<br>[39-502] | 20 N                        | 3 min.             | 150                    | 75                     |
| <b>Final Polishing</b> | COLLO<br>[39-085-250]    | Colloidal Silica<br>[39-600]   | -<br>-             | 15 N                        | 1 min.             | 100                    | 50                     |

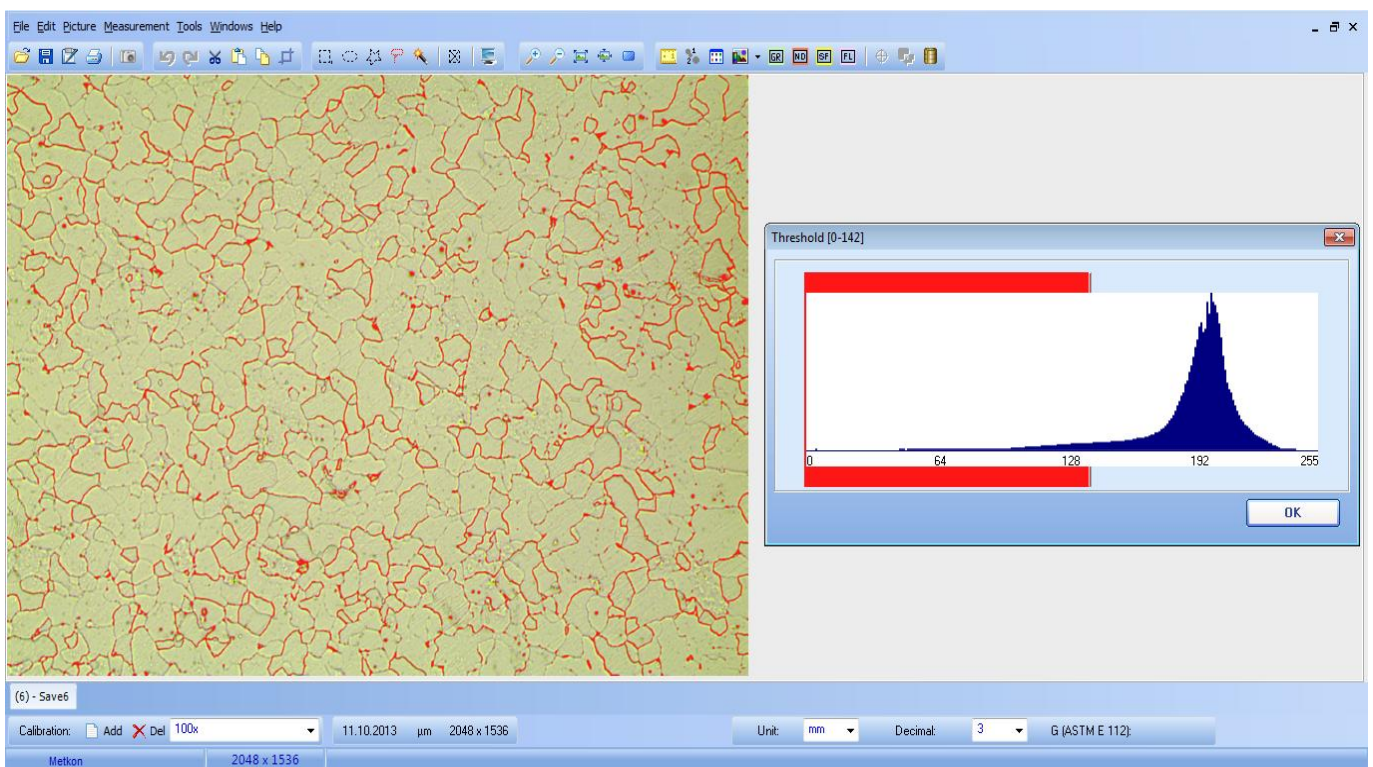
Total grinding & polishing operation took 12 min. approx. After polishing operation samples etched with 2% Nital solution for microscopic analysis.



After metallographic preparation, optic microscope images of the samples can be seen below:

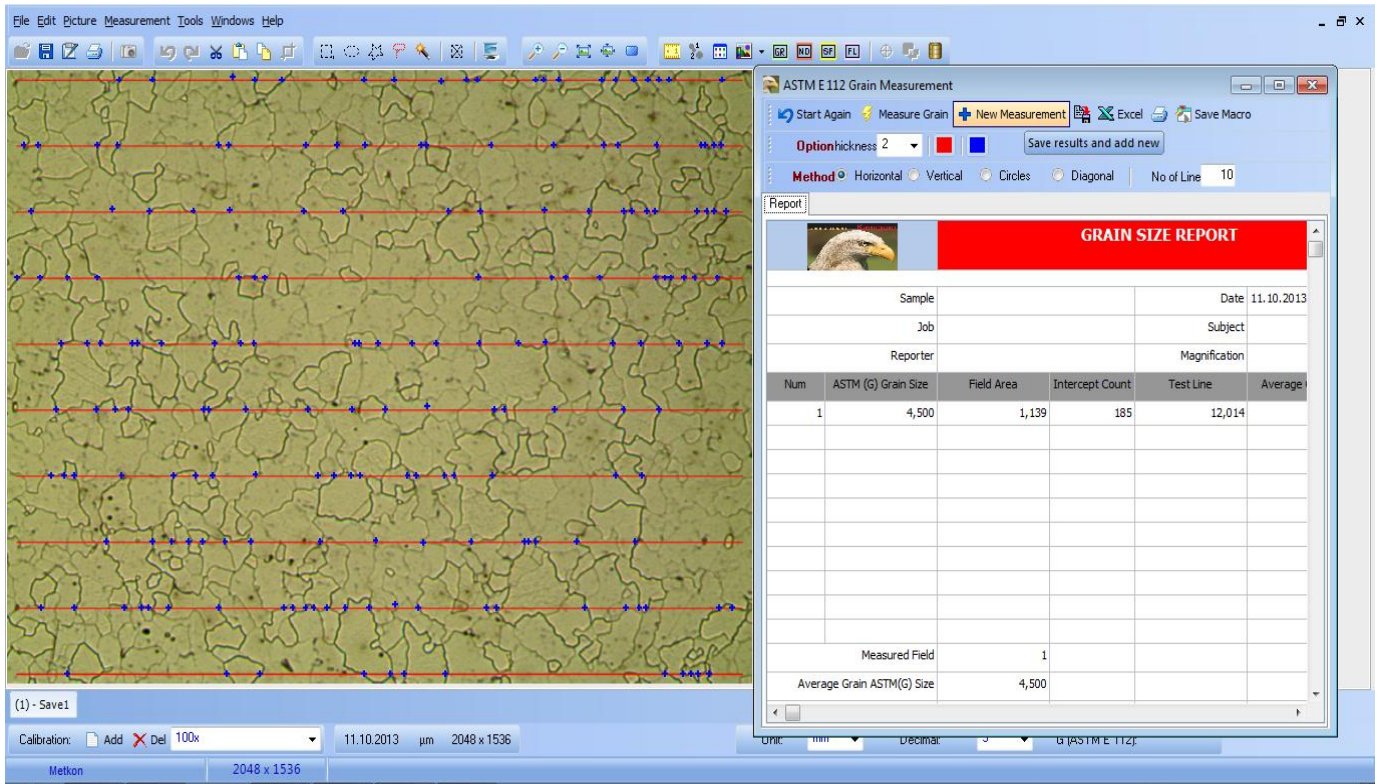


GRANO 200 software determines the grain boundaries automatically.



Painting color can also be selected by the color control. Following dialog appears when Threshold button is clicked. You can paint and select object regions by sliding the red bar according to grains shape and density.

Software generates several lines on the grains and detects intersection points. Number of lines can be adjusted. You can add new points on the image by manually or delete wrong points.



According to ASTM E112 standard the grain size value observed 4,5

This report can transfer to the Excel file directly.

| GRAIN SIZE REPORT          |                     |            |                 |           |                      |
|----------------------------|---------------------|------------|-----------------|-----------|----------------------|
| Sample                     |                     |            | Date 11.10.2013 |           |                      |
| Job                        |                     |            | Subject         |           |                      |
| Reporter                   |                     |            | Magnification   |           |                      |
| Num                        | ASTM (G) Grain Size | Field Area | Intercept Count | Test Line | Average Grain Length |
| 1                          | 4,5                 | 1,139      | 185             | 12,014    | 0,065                |
| Measured Field             |                     | 1          |                 |           |                      |
| Average Grain ASTM(G) Size |                     | 4,5        |                 |           |                      |
| Std.Dev.                   |                     | 0          |                 |           |                      |
| Measured Total Area        |                     | 1,139      |                 |           |                      |
| %95 CI                     |                     | 0          |                 |           |                      |
| %RA                        |                     | 0          |                 |           |                      |
| SIGNED BY                  |                     |            | Unit mm         |           |                      |

21.10.2013  
METKON LAB