The nature of scratching – Basics as well as possibilities in practice

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We are living within different materials,

are surrounded of their surfaces .

Each trace on a high-quality surface, left by a mechanical influence is felt like a big decrease/ impairment of quality and will not be accepted by the very most end users.

→Prime example: Cars

Therefore, nearly everything around us, mostly industrially manufactured, is intentionally targeted attached with special characteristics to prevent possibly any left of traces.

Within the judgement of high quality surfaces, there is no other theme understood as well as interpreted in so many different directions like the Scratch resistance .

The main intention is simply to create a mechanical influence, which leaves a rateable trace on the surface to be tested.

→Repeatable defined test specifications.

→Comparability.

→Expression of the result in numeric values.

. . . and here begins the possibility of quite different

understandings regarding Scratch Resistance:

Very often, Scratch Resistance is understood as the equivalent to Hardness (“Scratch Hardness“). This is one of the common misunderstandings in the judgement of coating materials.

The main importance is not really everytime about the hardness, but, only simply about the characteristic, that a mechanical influence does not leave a trace on the surface.

This can be achieved by, for example:

→High “Hardness“.

→“Sliding“.

and/or

→“Avoiding“.

Hard =

Oftenly accordingly brittle, and therefore even more damageable against scratching influences.

So-called “Nano“ –Coatings:

→ Drastic increase of the surface sleekness.

→ Extreme surface hardness.

→ Sliding (away) of normally damaging influences, without leaving any scratch trace.

“ Extremely hard as well as slippy coatings“.

Firstly, this seems to be a universal solution.

But, unfortunately, this is oftenly only suitable

for stiff substrates.

Bending / Tension of the substrate / Different

Expansion Coefficient of Substrate and Coating during

temperature changes.

→ Loss of Coatings‘ Adhesion.

A commonly important characteristic /

necessity for a good adhesion of coatings

is their elasticity.

→ A soft and resilient appearance of the coating.

→ The very most users expect a lower scratch resistance.

But, the coating material can avoid the damaging mechanical influence by bending or elastic fluxion and escapes from the damage endangerment situation.

Paradox : Due to the good scratch resistance, in the sense of many users, mistakably, the coating material seems to be quite hard.

A trace in form of a plastic deformation:

→Visually distinctly less eye-catching than a ripped surface.

→Depending of the material‘s individual rebound effect, time-depending “self-healing“.

Against undesirable ripping of the surface:

→“Slip“-Additives.

→Making the surface more slippy.

→Causes a “sliding away“ of the potential damaging mechanical influence

Due to this, the main subjective criterion for “Scratch Hardness“, the leaving or non-leaving of a trace, could create a lot of confusion regarding the user‘s understanding of the “Material‘s Hardness“.

Different scratching tools respectively different test tips create, due to their individual geometry, different types of scratch traces.

Test Tips

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Conclusion:

Really important, regardless of the users‘ own individual understanding of “Hardness“, is only the characteristic / ability of the surface to avoid eye-catching visible traces after treatment by mechanical influence!

What remains, is the necessity of “Tailored Testing“!

Each possibly destroying mechanical influence

has to conquer/penetrate firstly the upper surface,

before it could be further damaging effective!

→Therefore, in the very most cases,

the separate testing of the upper surface

is still a matter of highest importance!

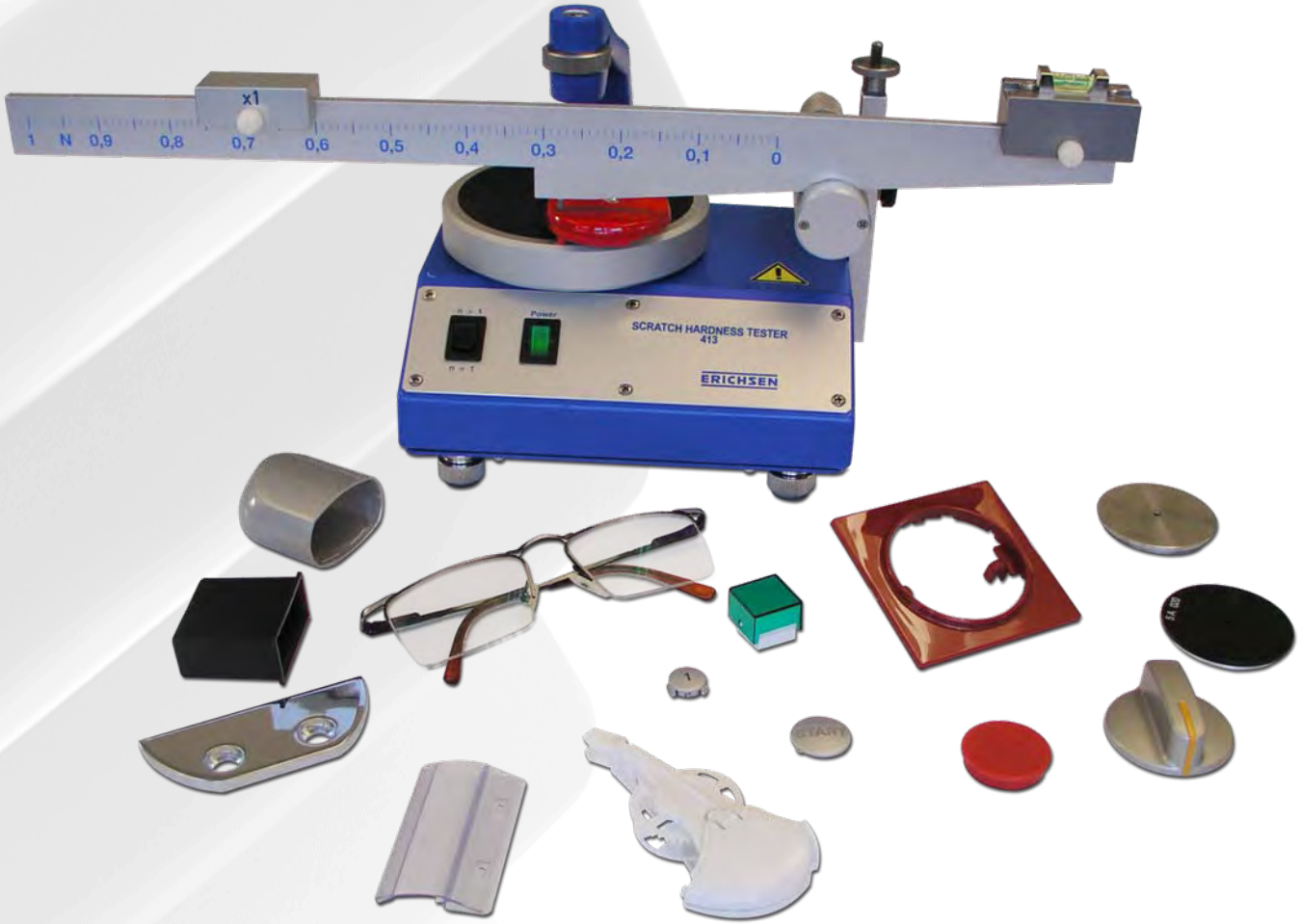
After a lot of Scratch- as well as Abrasion Testings, the judgement of the materials‘ surface is mixed into the complete test result, without any possibility of its separate indication / quantification.

ERICHSEN Scratch Hardness Tester 413

enables the separate testing of the specimens‘

upper surface!

SCRATCH HARDNESS TESTER 413



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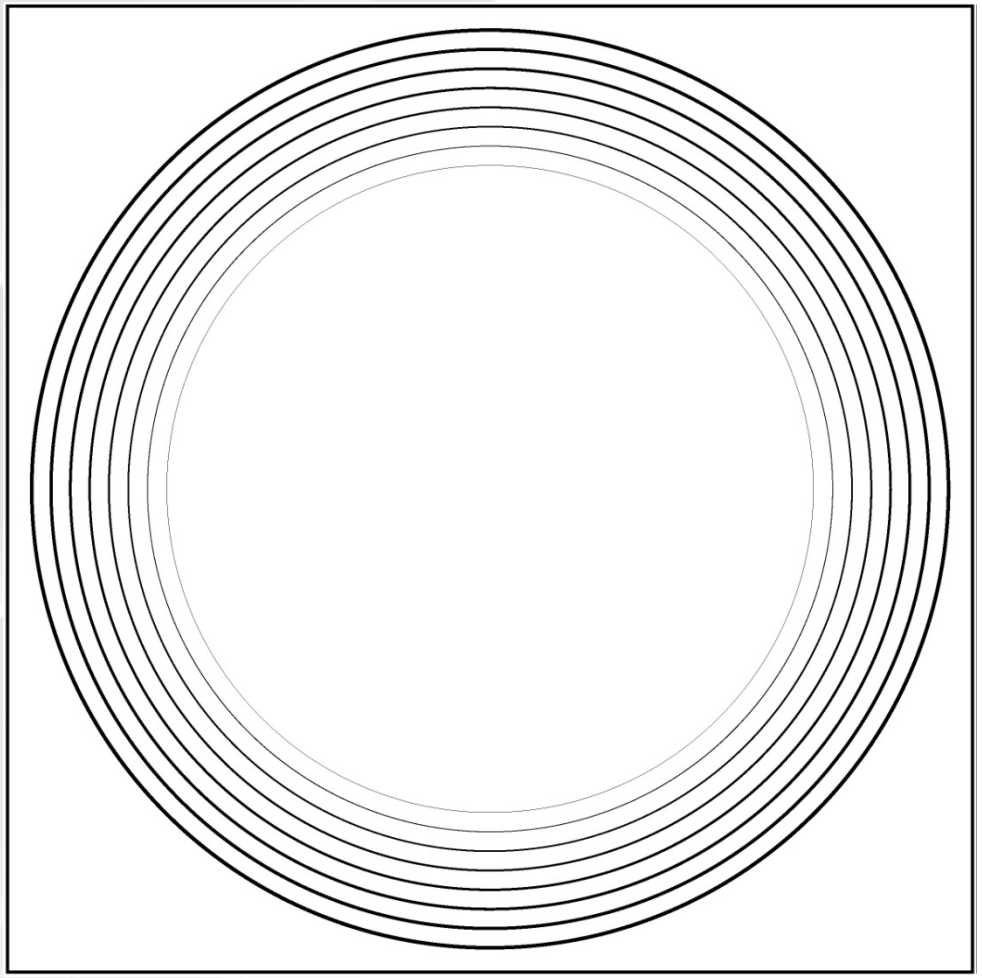
→ **The interpretation of the surface‘s**

quality, in numeric values!

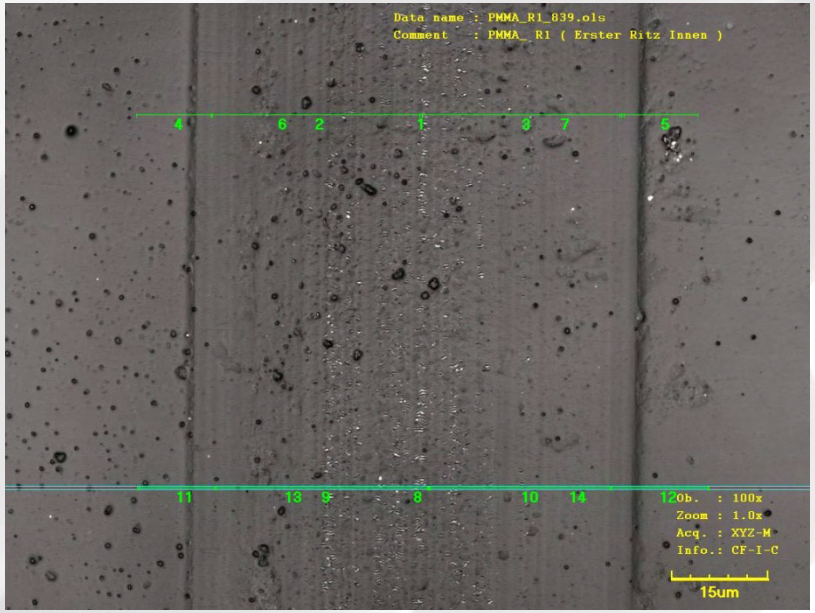
Due to its extraordinary fine stepped scratch force adjustment (0,01N), even finest tendencies in changing or differences in scratch resistance / “scratch hardness“ are recognizable!

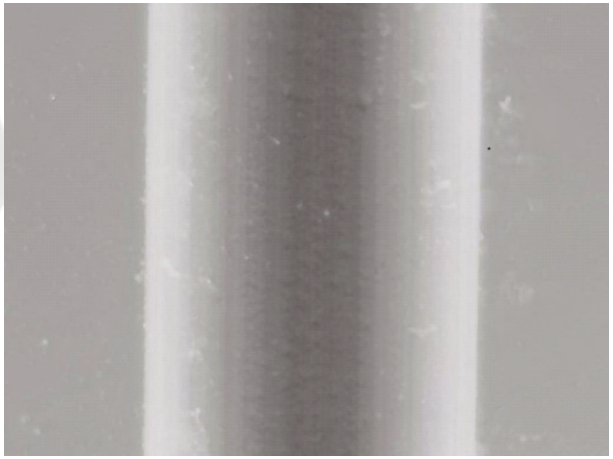
Target Pattern

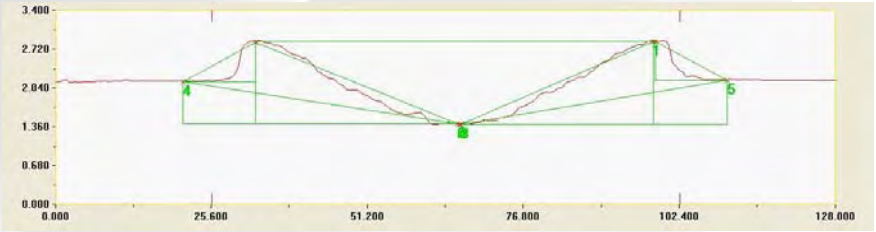


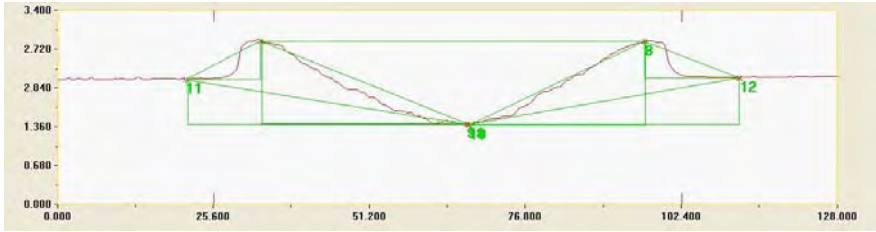
Target Pattern on a PMMA-Plate

Pic. 1









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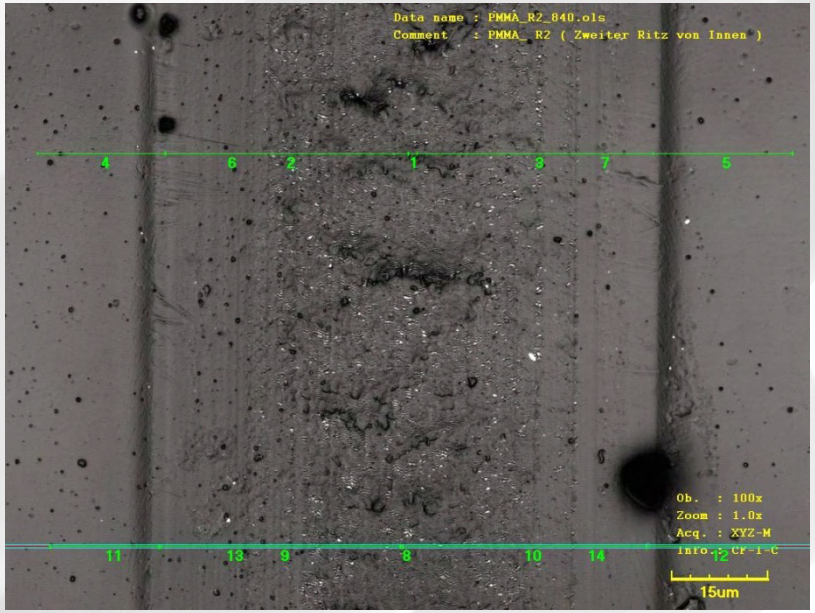
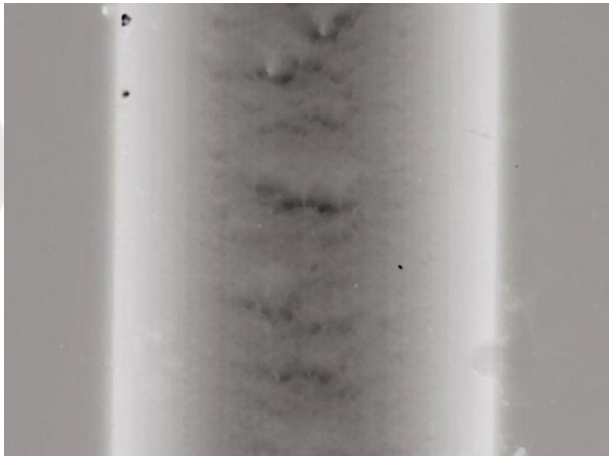
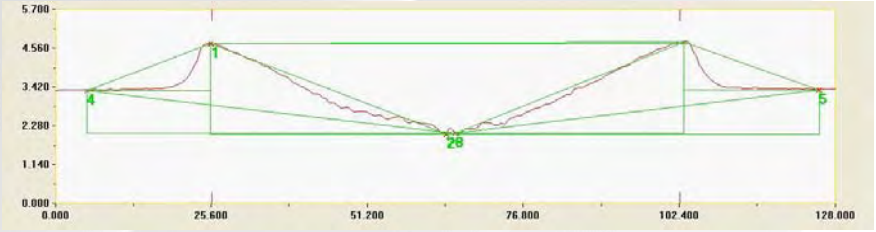
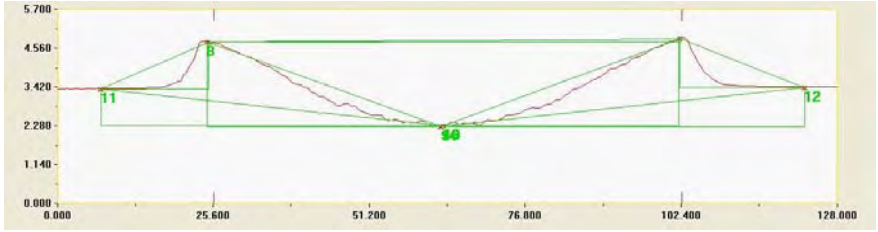
Pic. 2









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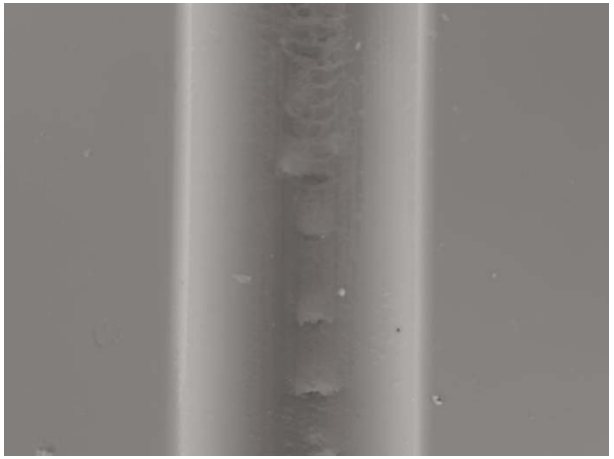
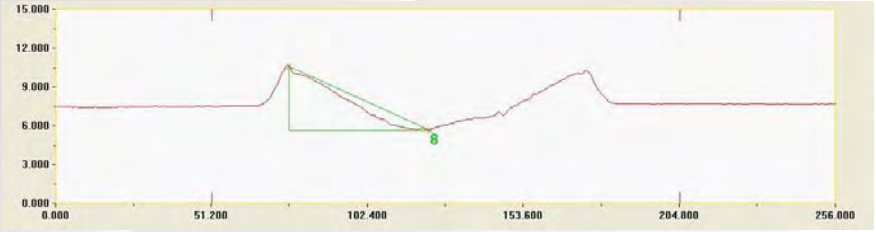
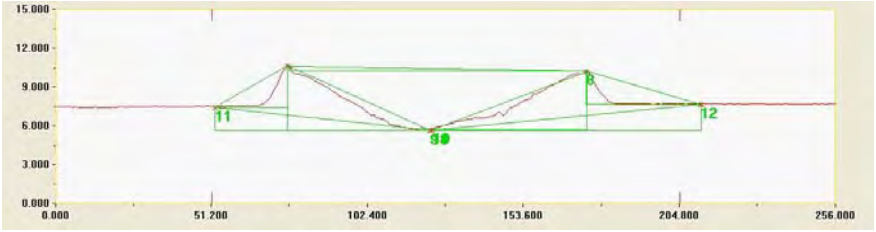
Pic. 3







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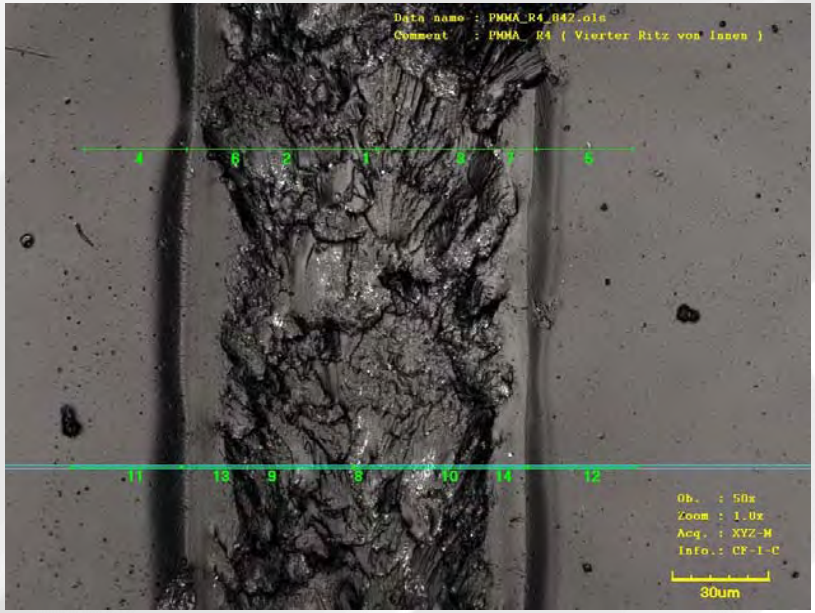
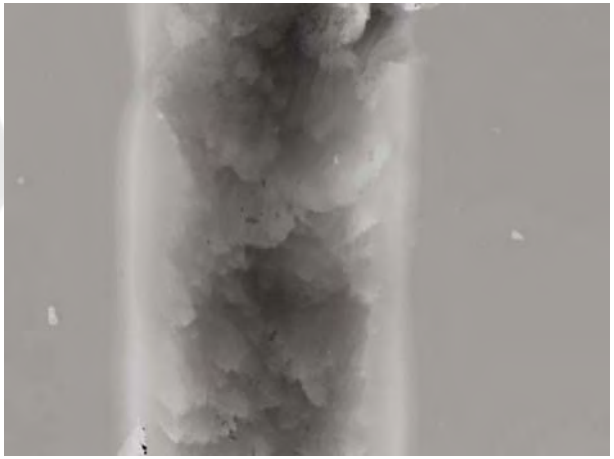
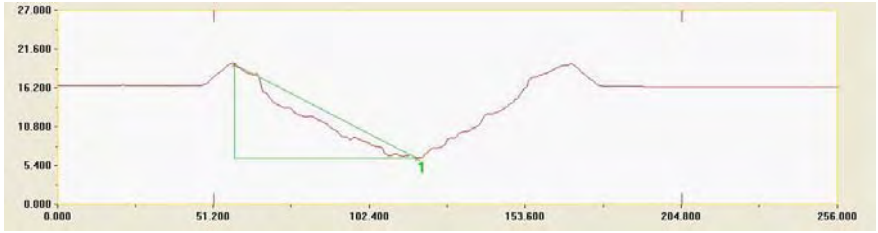
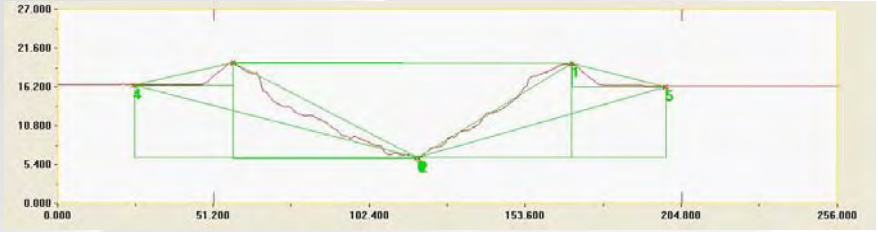
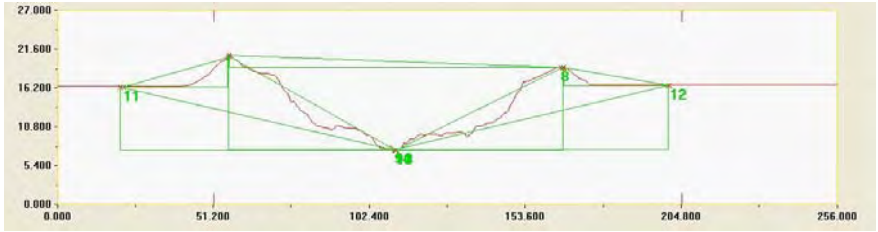
Pic. 4











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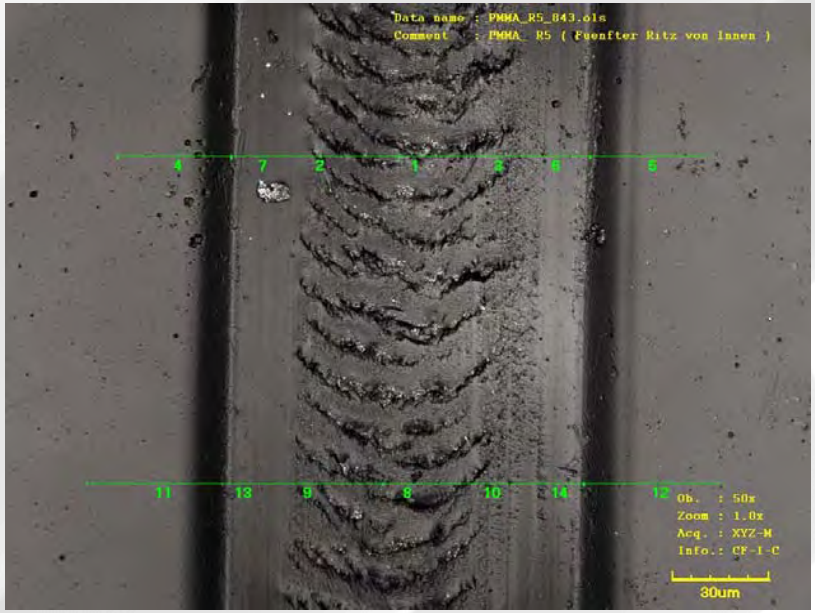
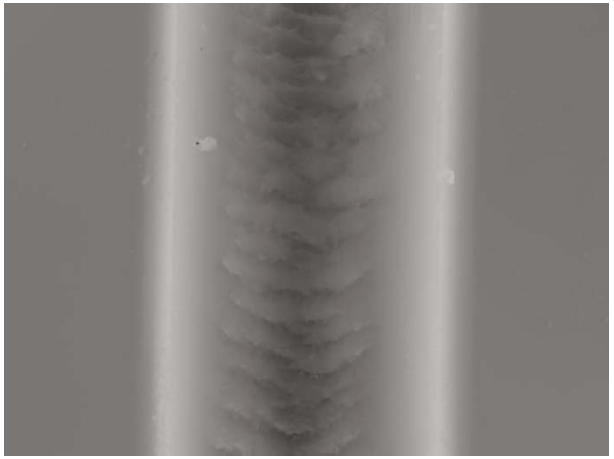
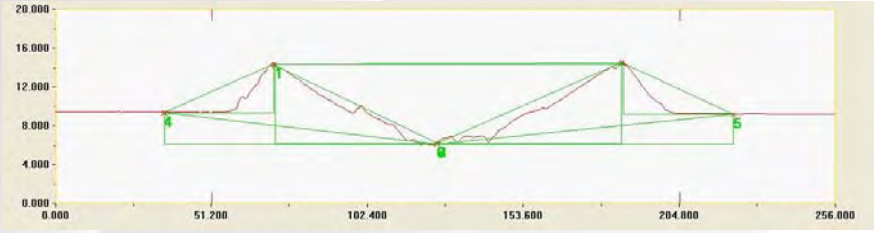
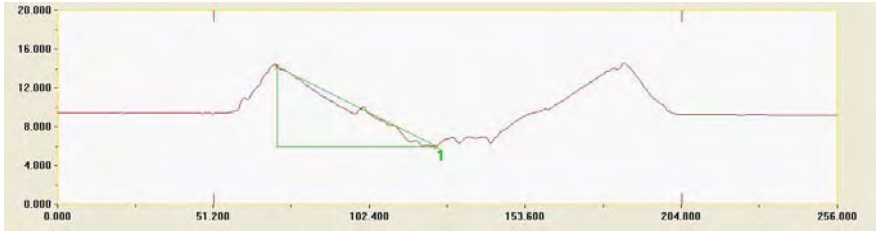
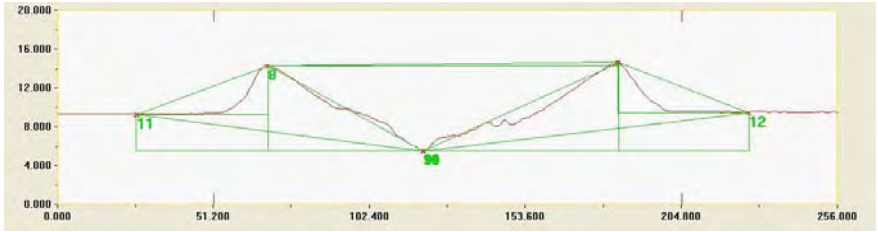
Pic. 5











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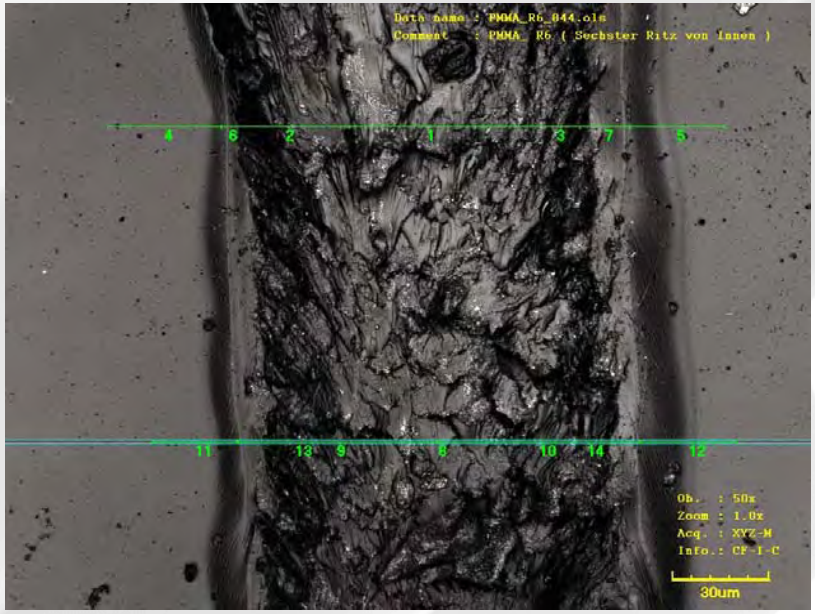
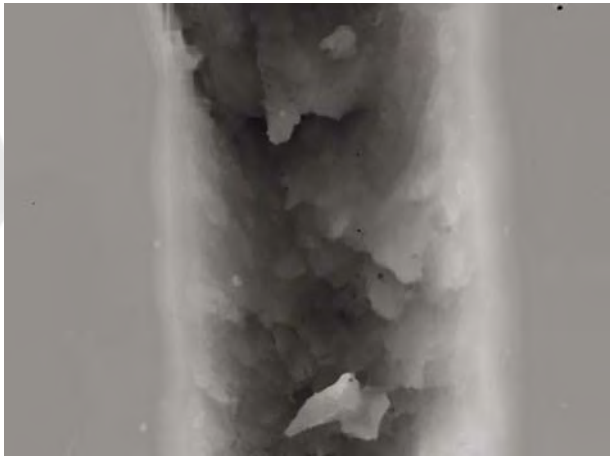
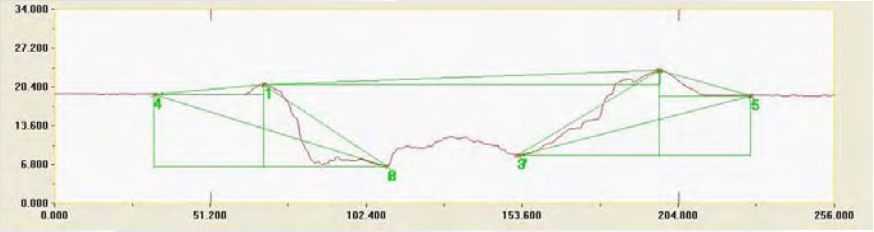
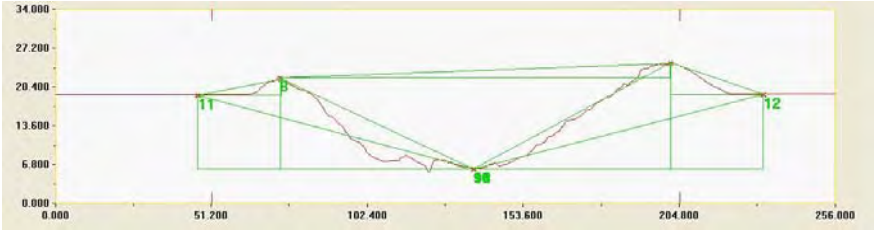
Pic. 6









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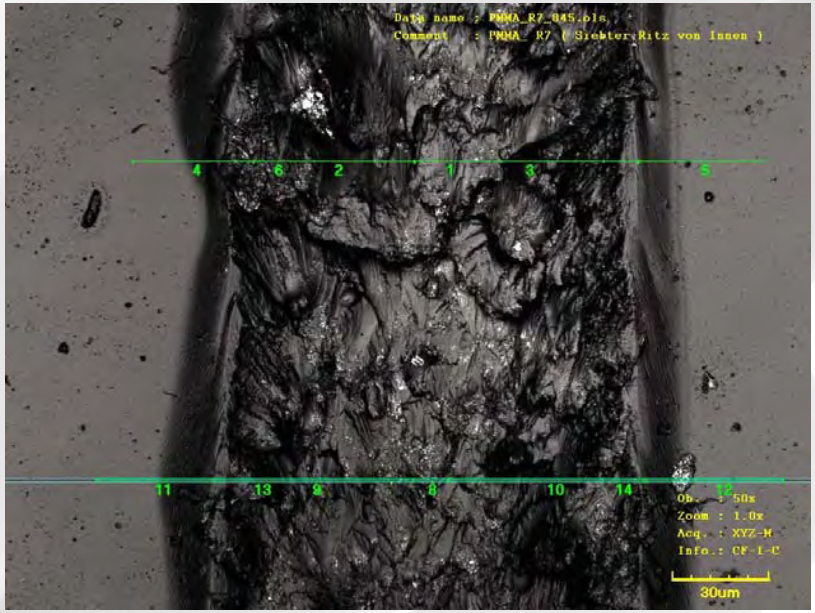
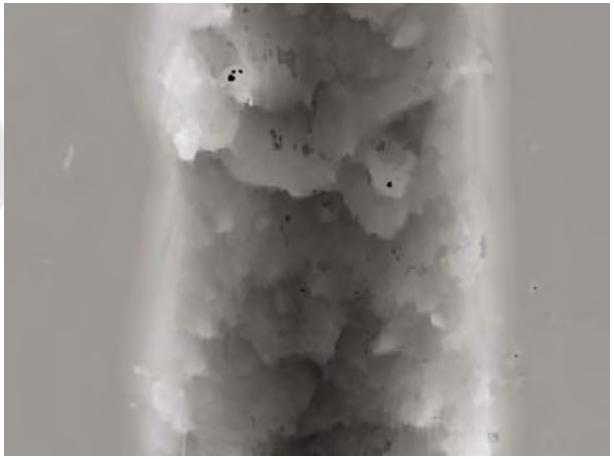
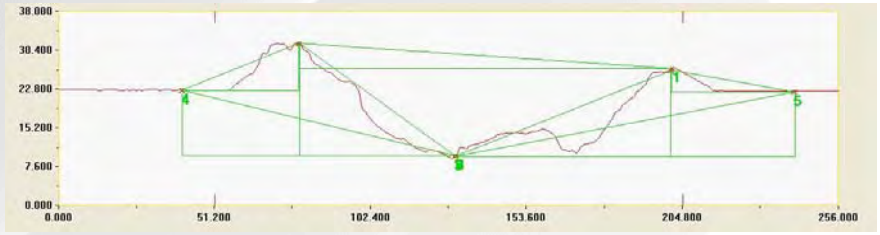
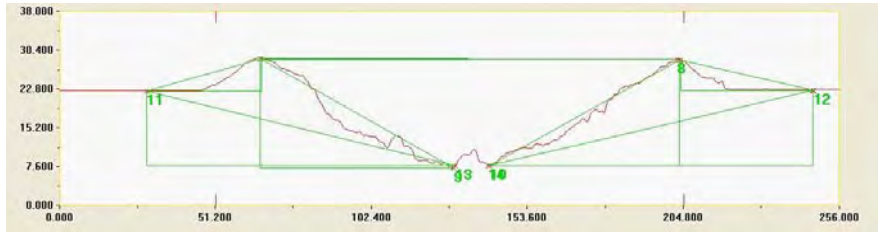
Pic. 7









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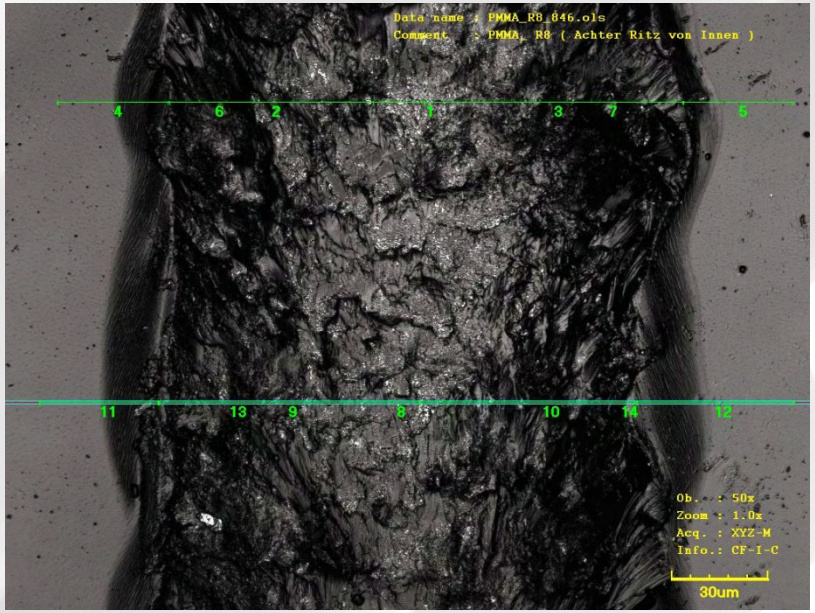
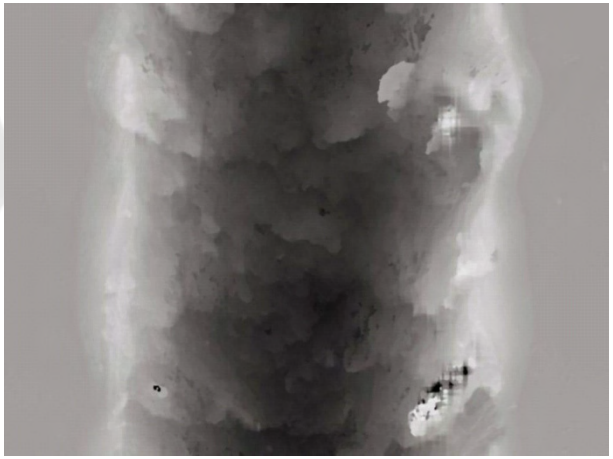
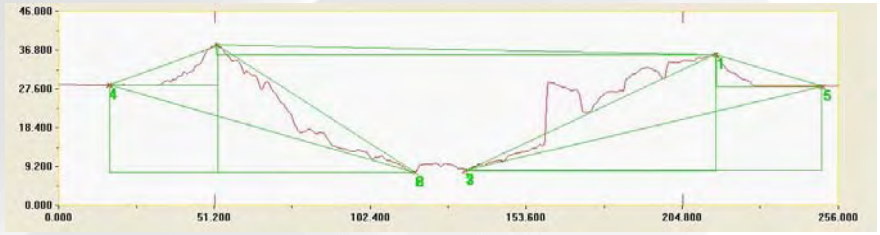
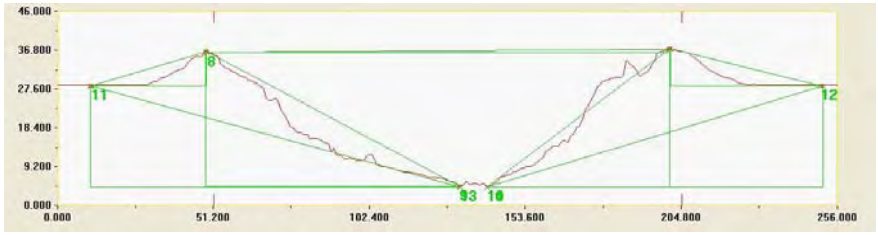
Pic. 8









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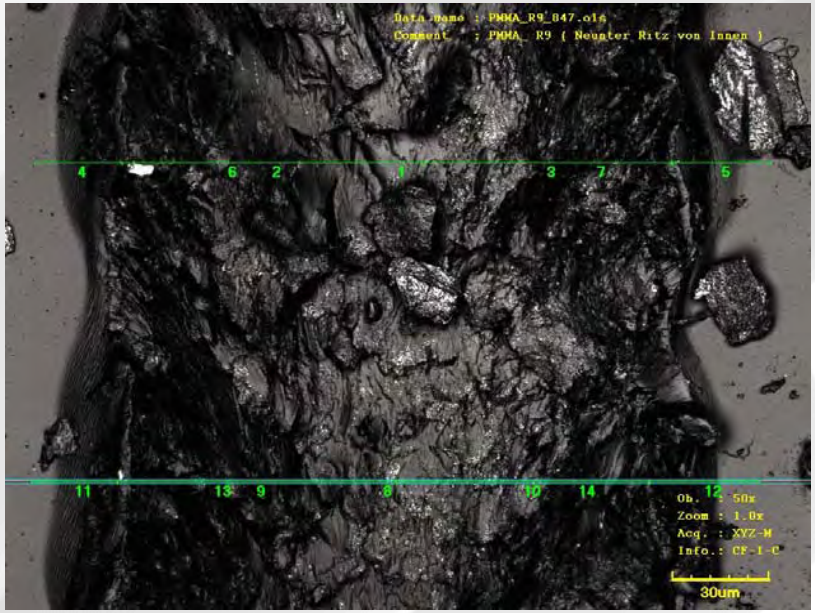
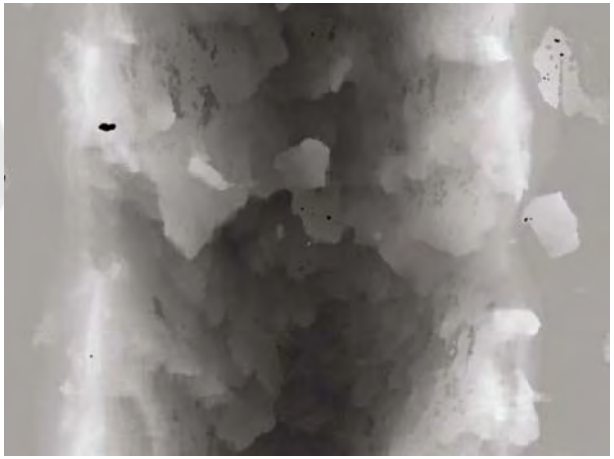
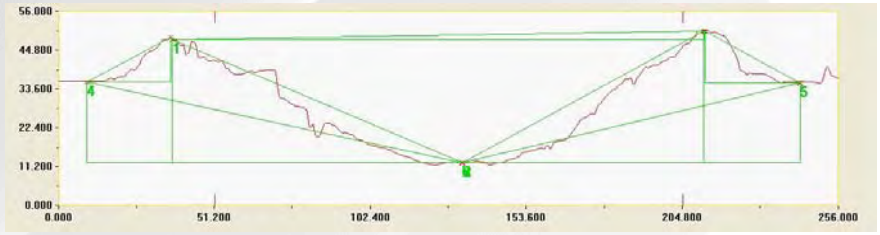
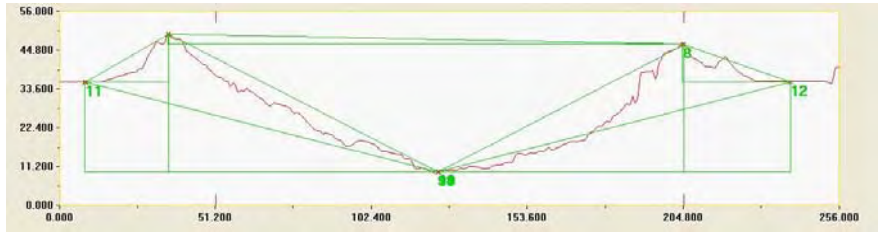
Pic. 9









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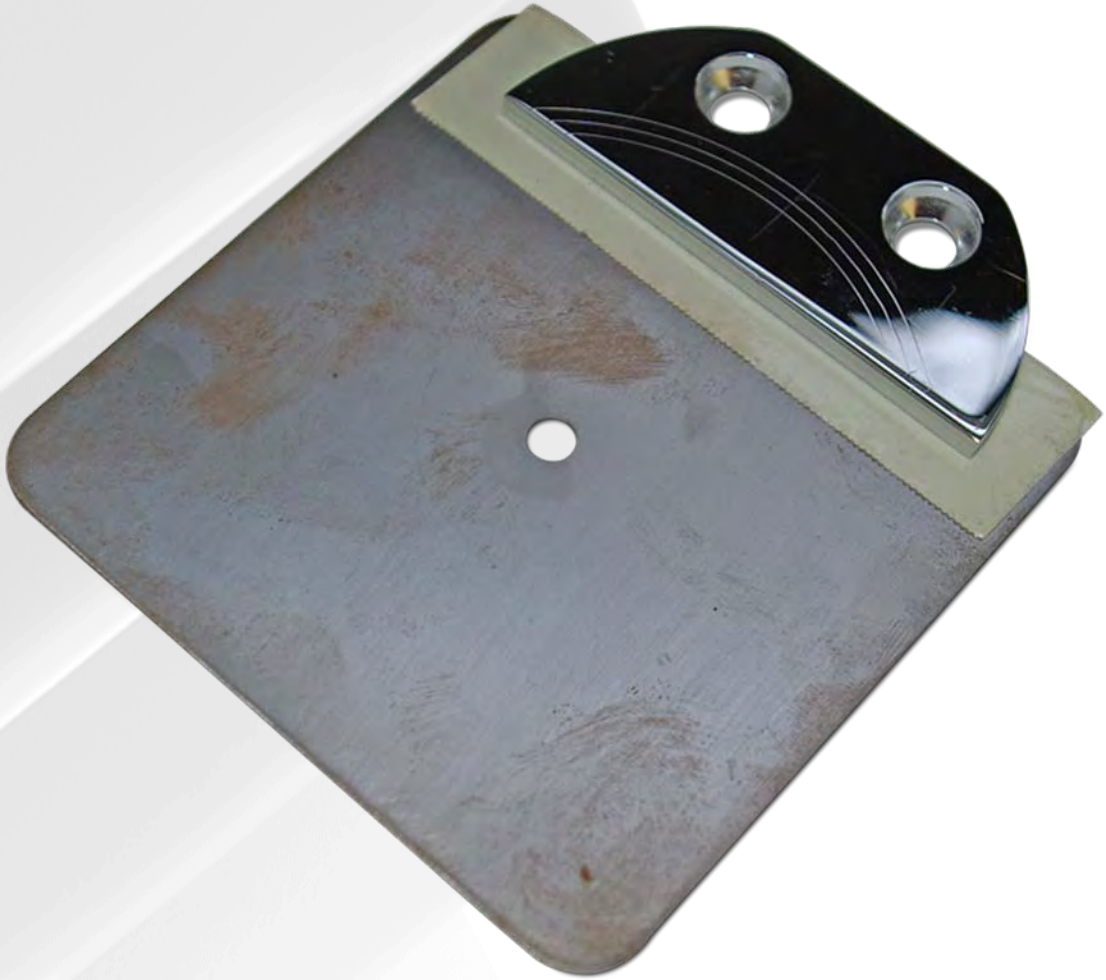
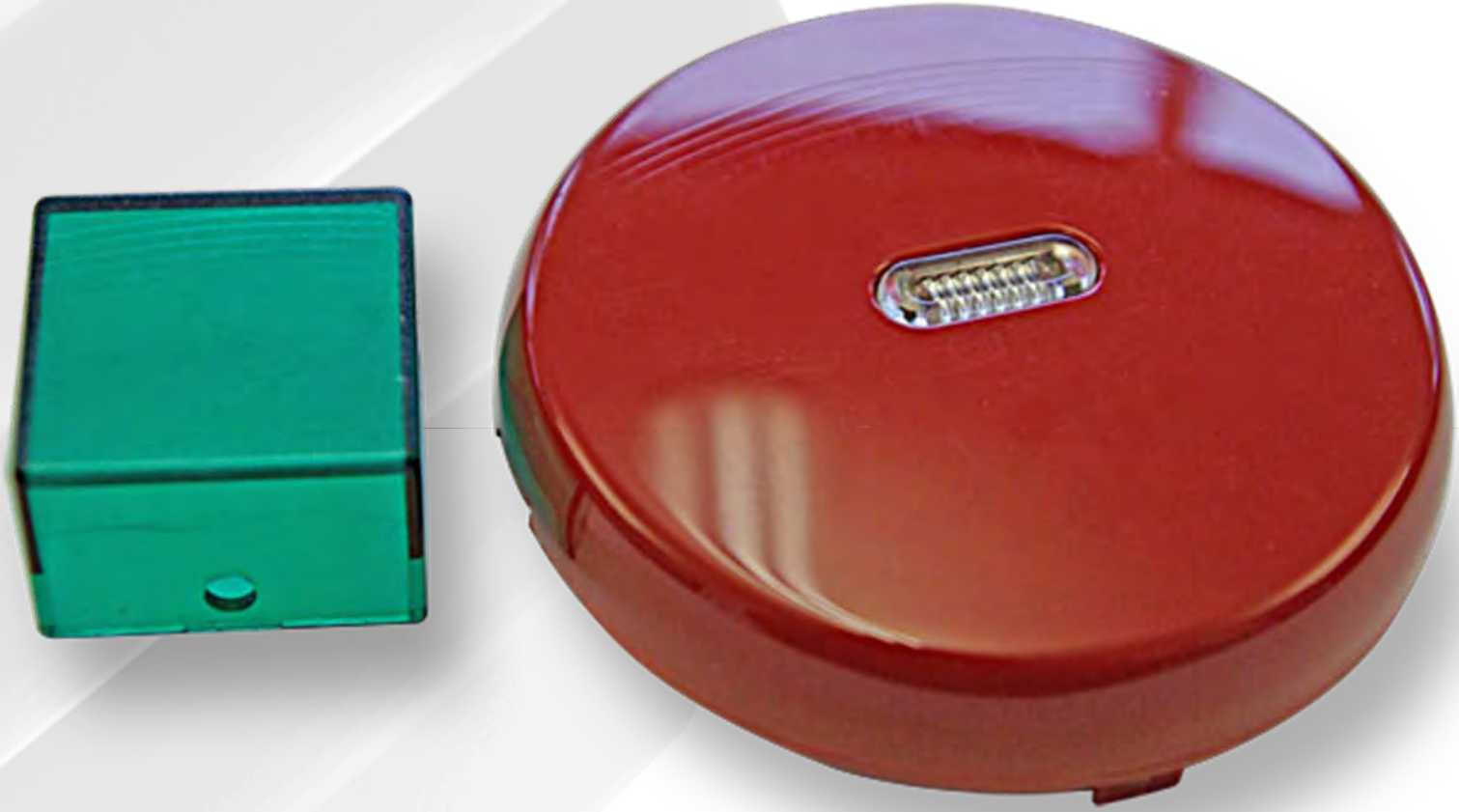
Scratched Steel Specimen



Scratched Light Switch



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Important: Characterization of the scratch traces

→Keyword “Noticeability“.

“Ripping“ of the surface

→ Multiple spreading/diffusion of the reflected light.

→ Visually, the trace appears a kind of white.

→ Distinctly visible, and therefore eye-catching.

→ Remaining, not reversible injury.

→ Stays distinctly eye-catching.

Plastic deformation as a scratch channel

→ No multiple Spreading/Diffusion of the reflected light.

→ No eye-catcher.

→ Could be possibly partly or completely reversible .

→ Keyword “Self-Healing“.

Different types of “Scratch Traces“:

1.) Ripped surface = Eye-catching, not reversible.

2.) Plastic deformation = In comparison distinctly unremarkable.

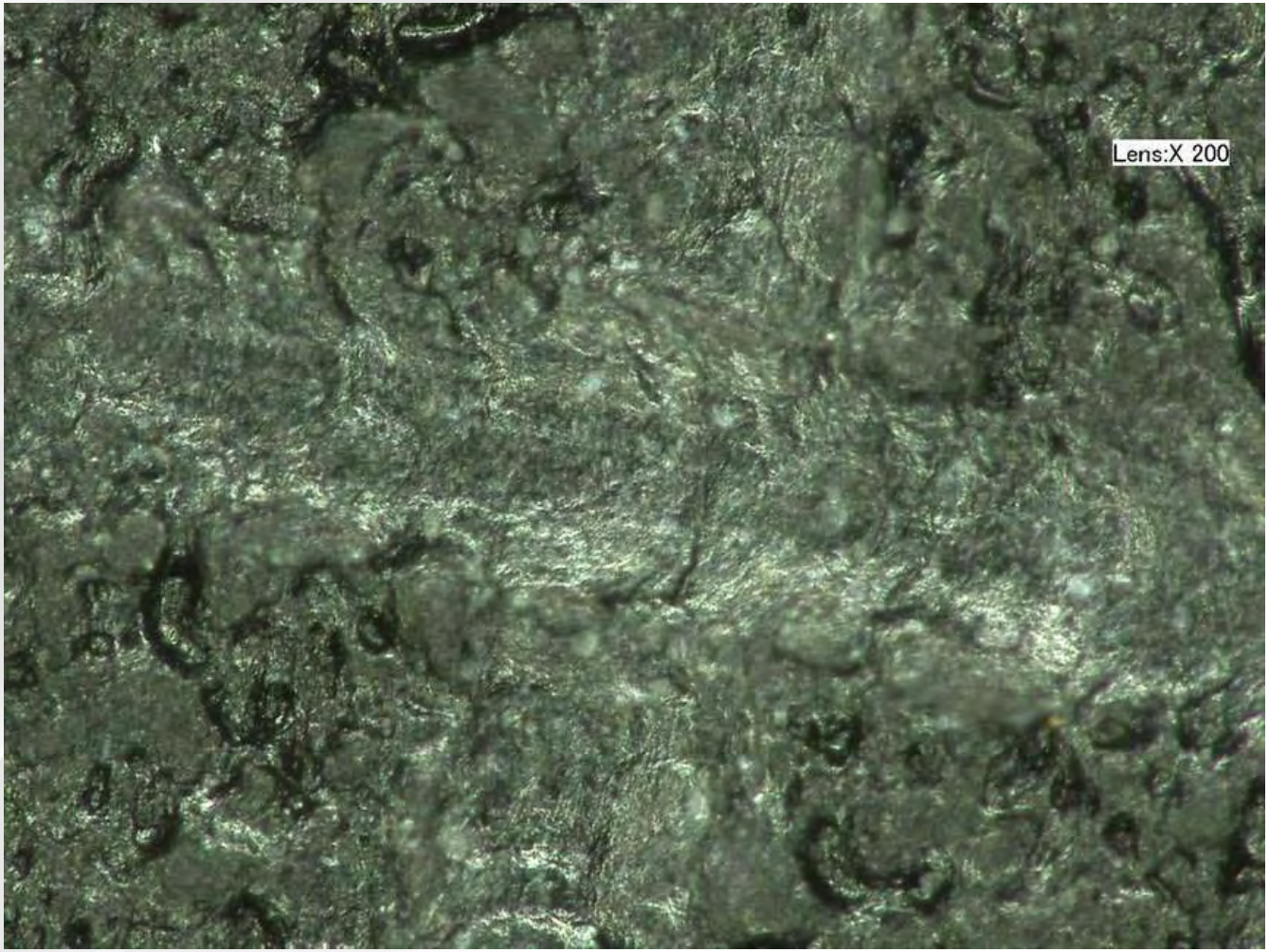
3.) Plastic deformation with following Re-Flow-Effect
= Like 2., possibly after a while no longer or only hardly visible.

4.) Polishing of “silky“ semi-gloss, or matt surfaces.
= Appears darker, in the most cases clearly visible, but, distinctly less recognizable than a ripped surface (Ref. to 1.), not reversibel.

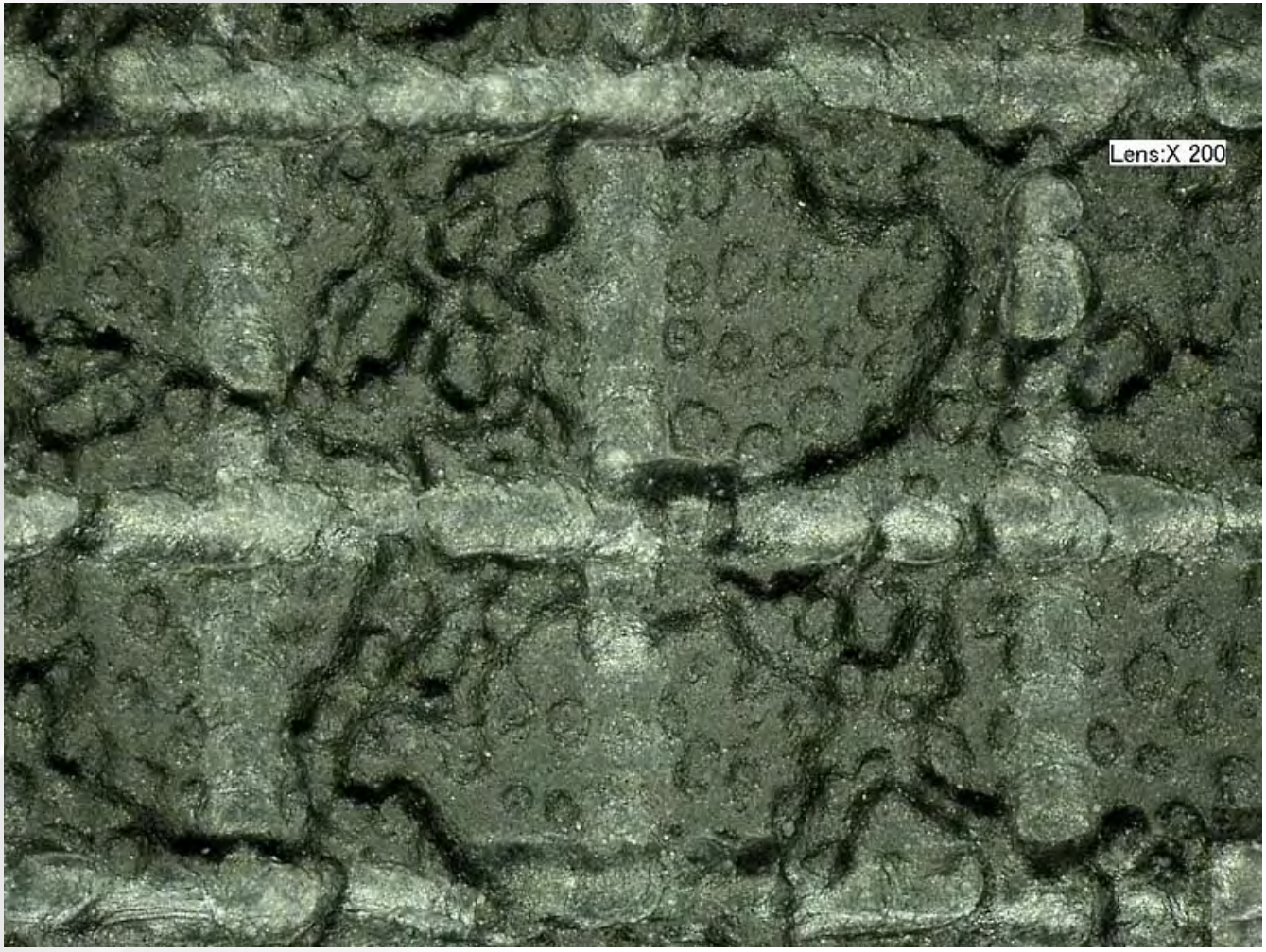
Another method for scratch hardness testing, with a continously increasing importance, regards to “Leather-Type structured Plastics Materials for Car Interiors“.

Several specimen, scratched acc. to GM/VW

Pic. 1



Pic. 2



Pic. 3

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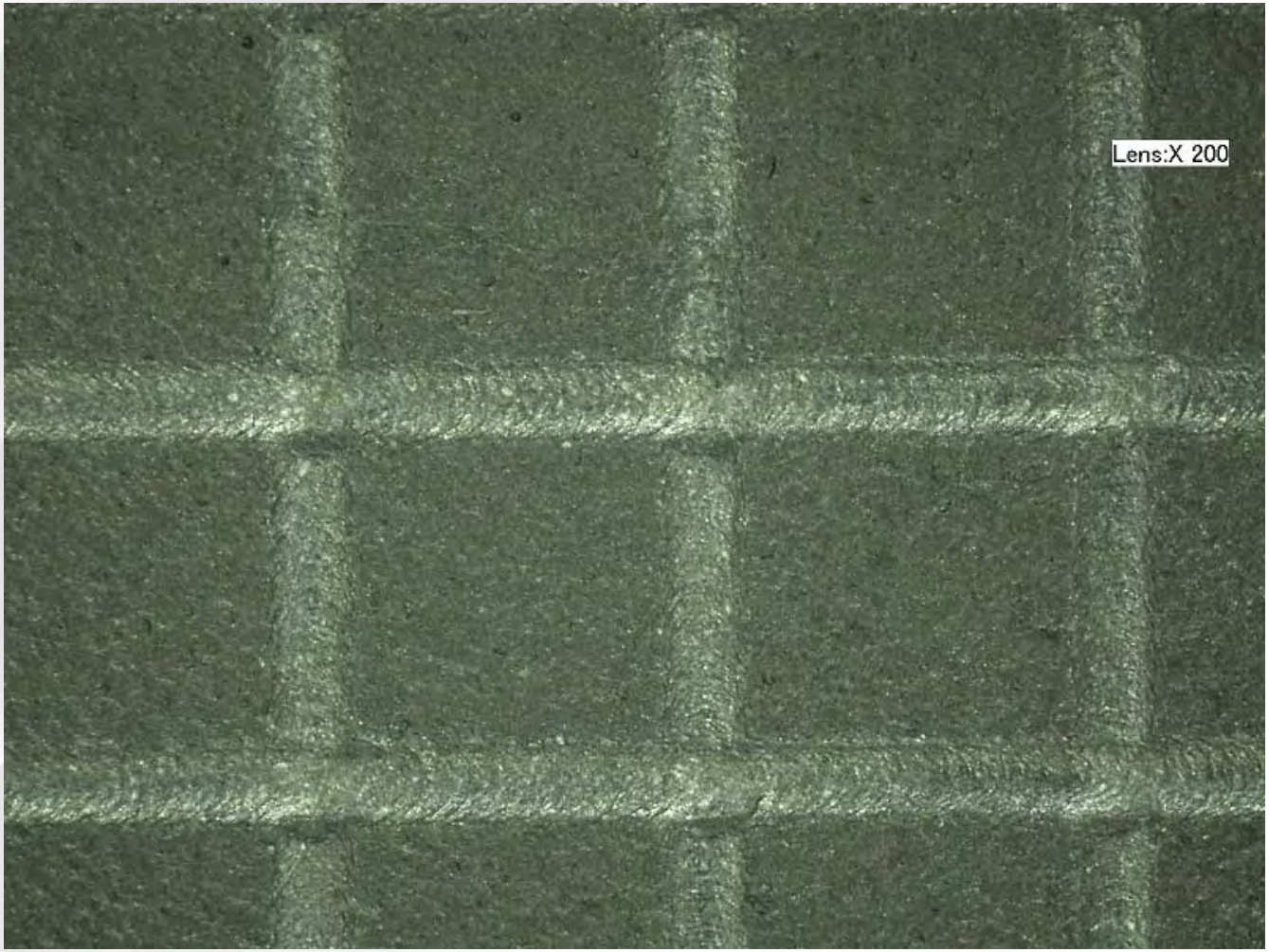
Pic. 4



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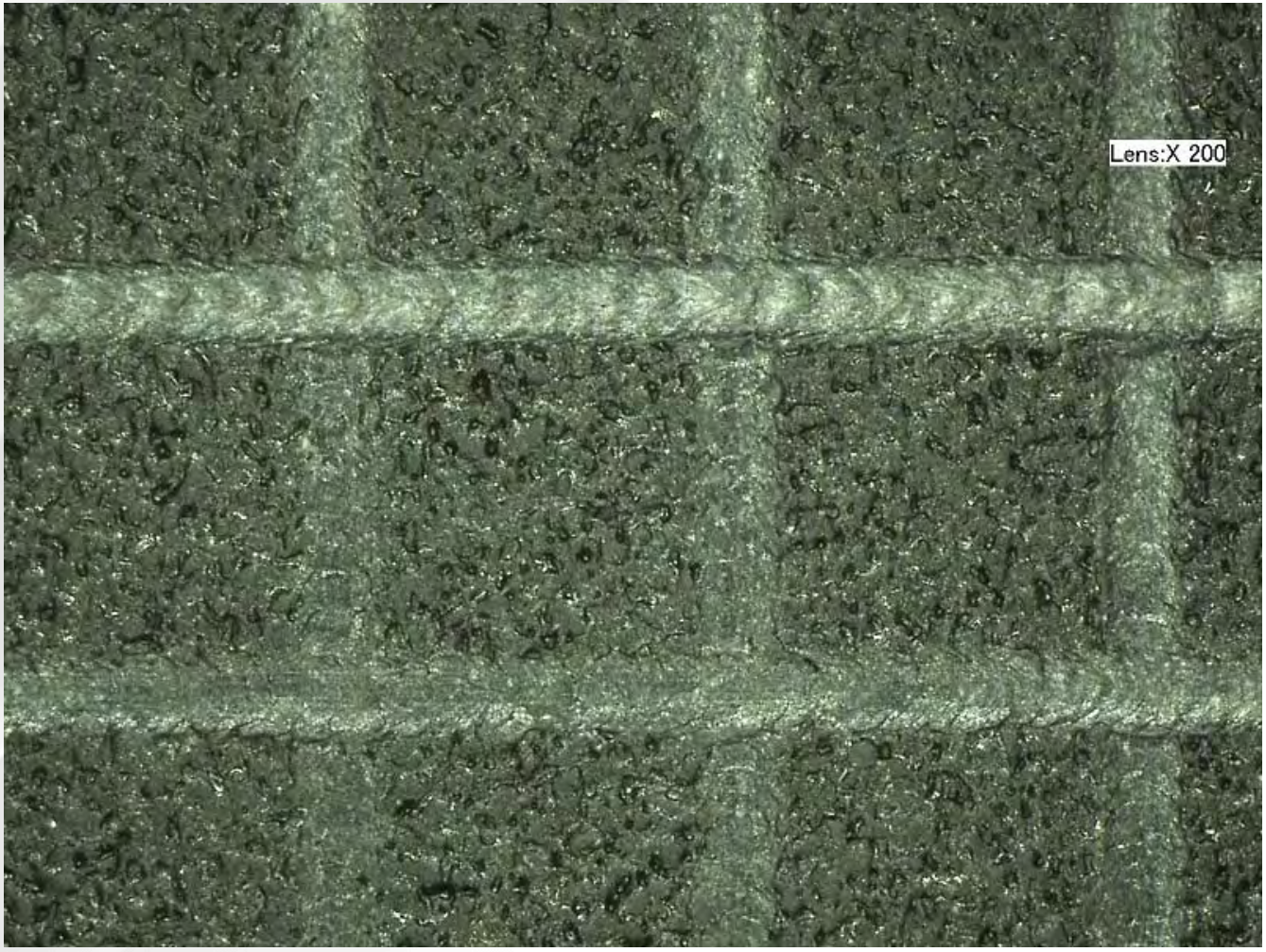
Pic. 5



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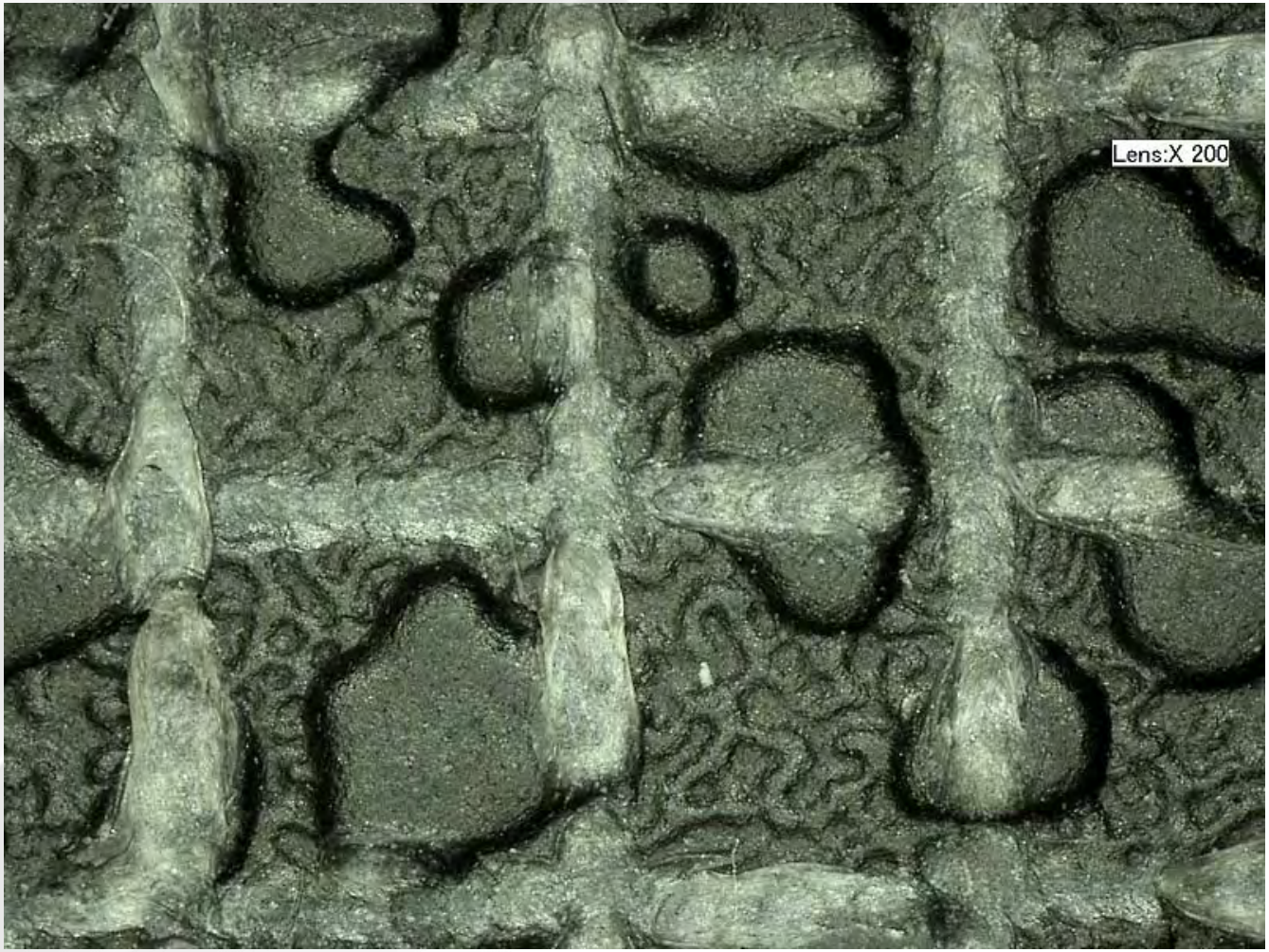
Pic. 6



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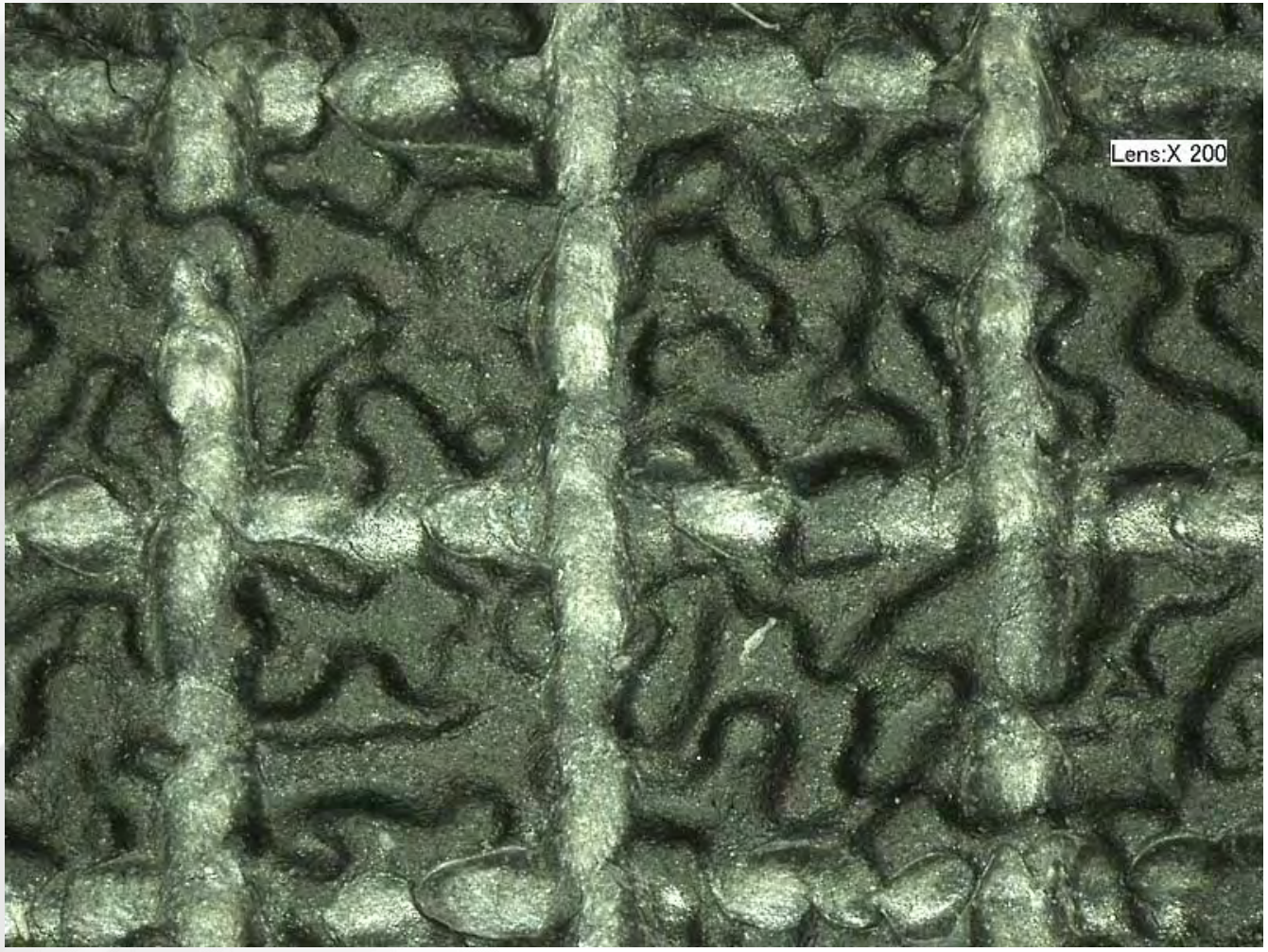
Pic. 7



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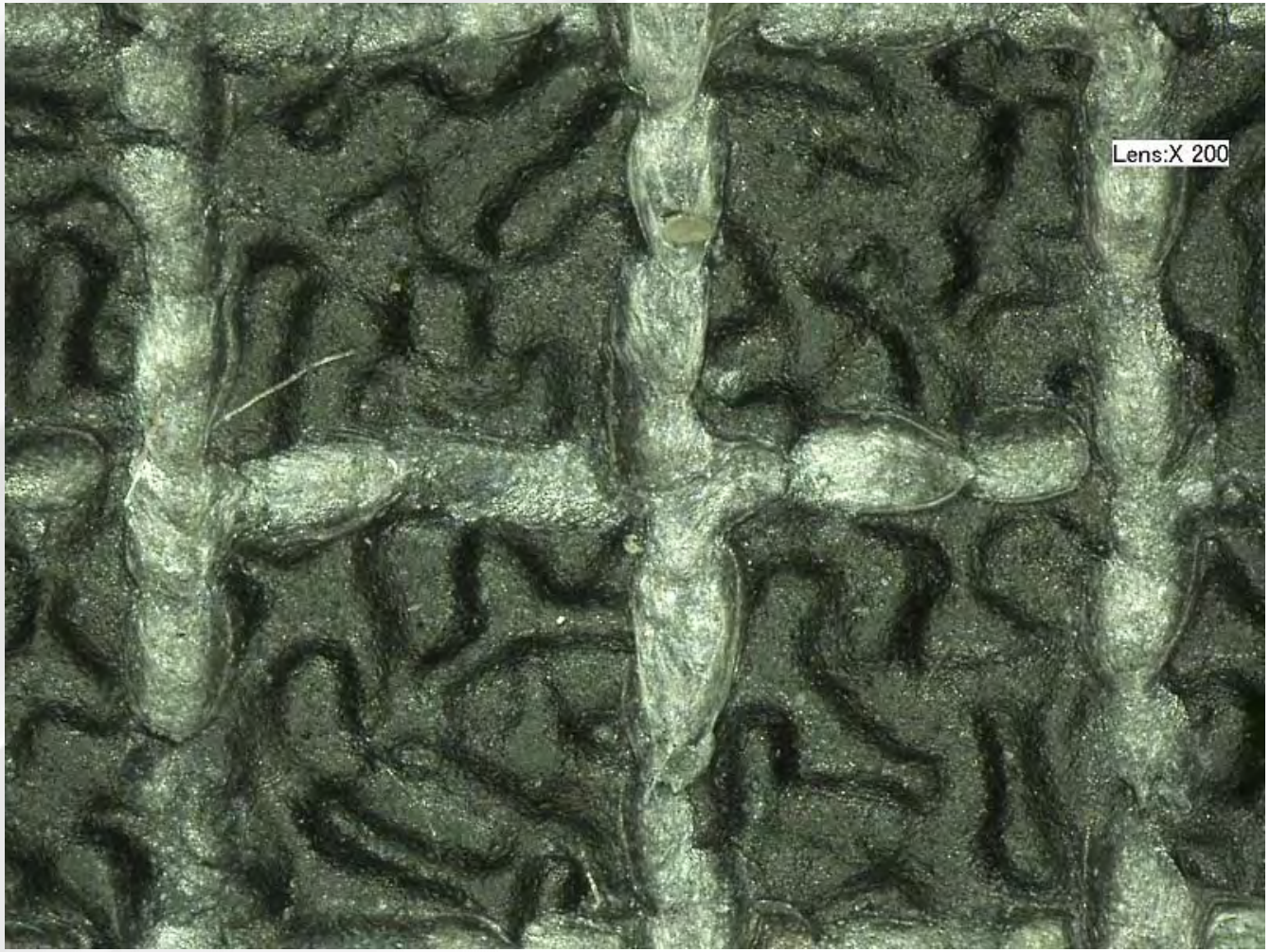
Pic. 8



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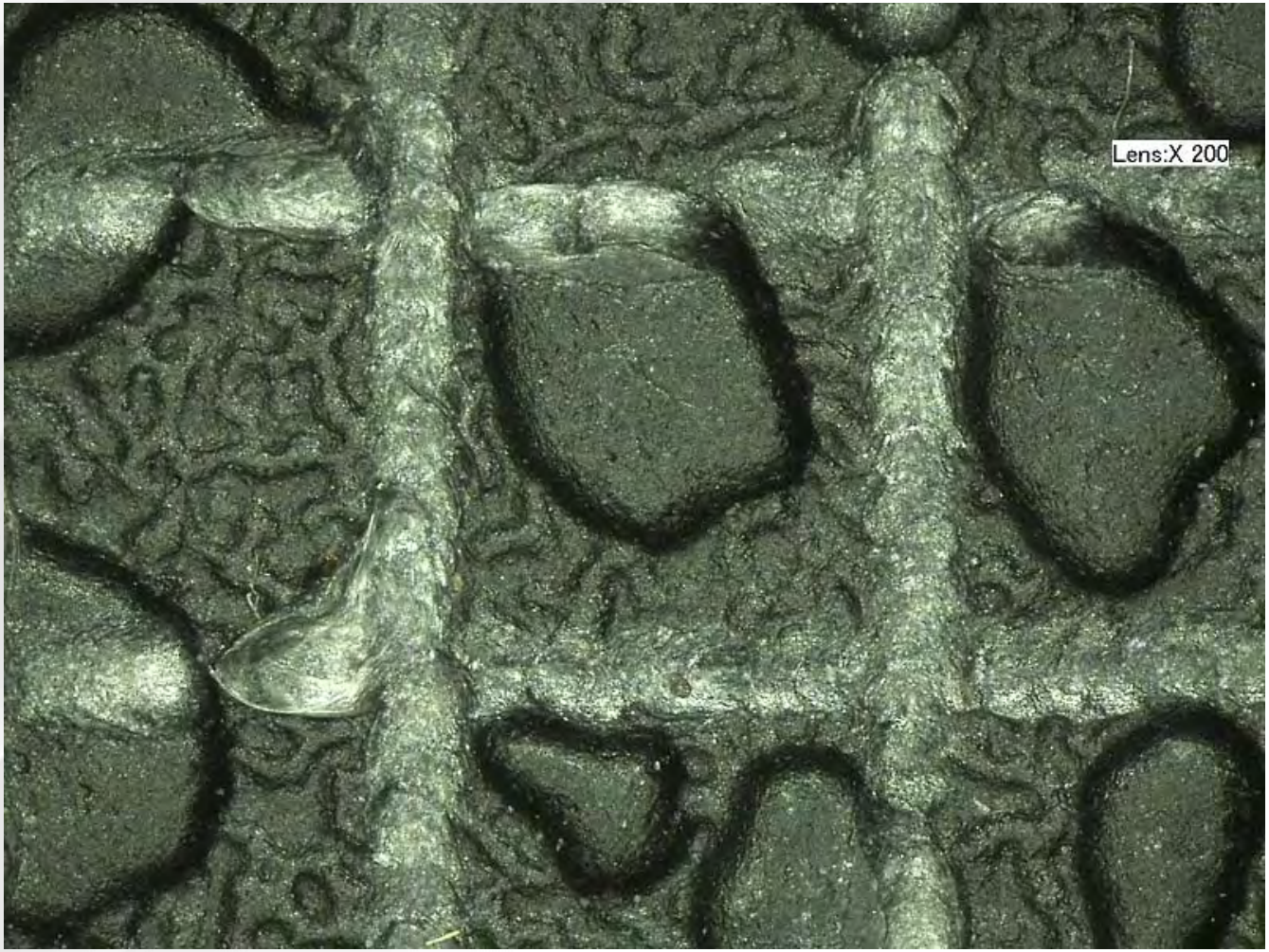
Pic. 9



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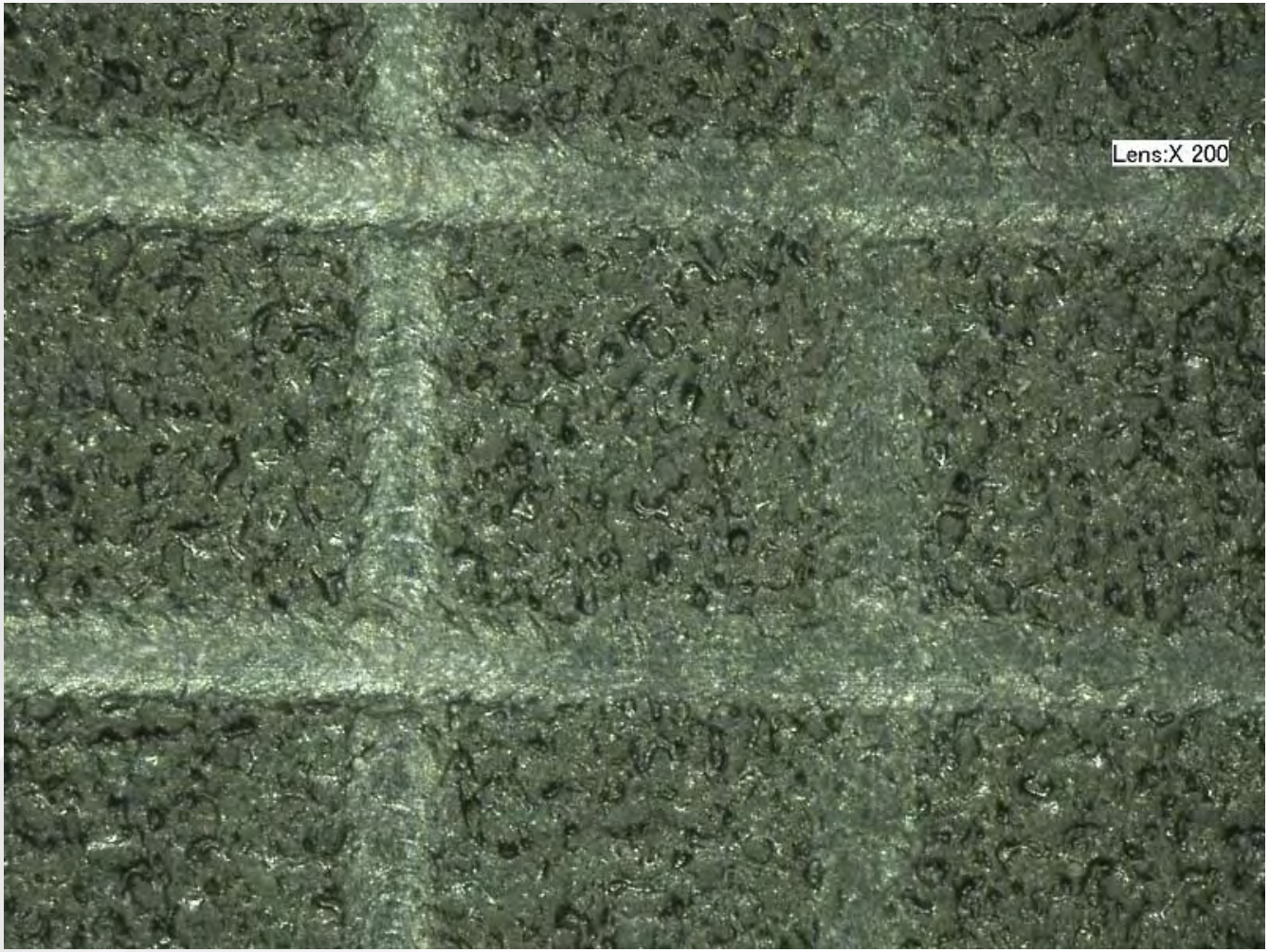
Pic. 10



Application of a kind of cross hatch pattern,

with a hard metal test tip, with a diameter of

1 mm and a scratch force of 5 N .

→20 cuts, with a distance of 2 mm between them .

If the quality of the plastics material is unsufficient (possibly caused by too much powder/pigment components with too less resin), the material could easily break at the edges of the leather structure.

With too much resin, it could possibly smear.

The appearance of these broken or smeared parts is normally brighter.

Due to this, in such case, the complete area of the “cross hatch pattern“ looks visually brighter.

This increase of brightness can be measured with a suitable Spectrometer.

It gives an expression of the brightness‘ deviation in numeric values: The so-called “Delta L“.

The origin of this test method is from

GM / OPEL /1998, and in the meantime,

it is established at more than 10 well-known

car manufacturers as well as at several of

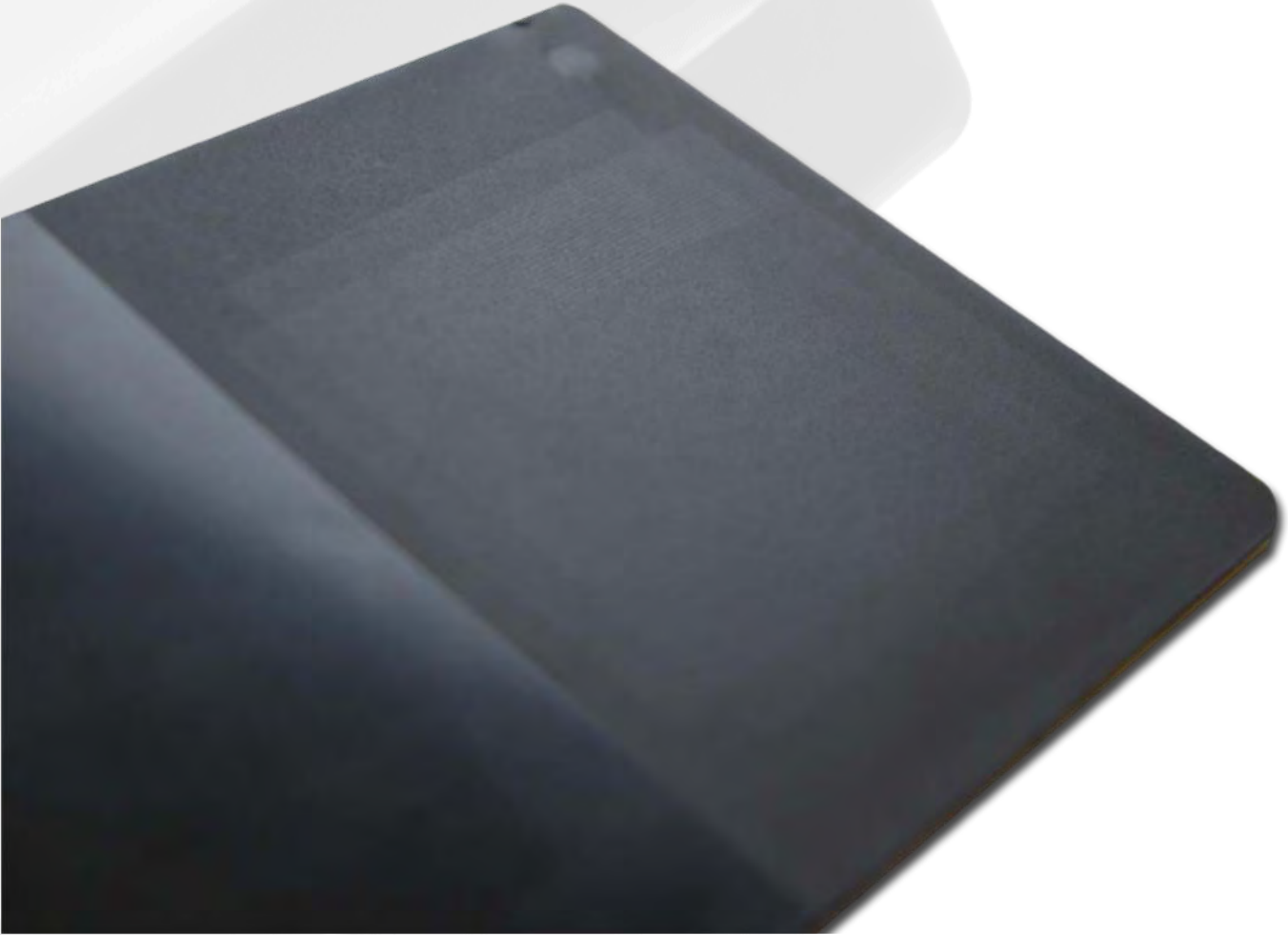
their sub suppliers.

It is also recommended by the VDA!

The concerning GM Standard has been enlarged about a further method:

Testing of the *“Writing Effect“*.

Test specimen with writing effect and writing effect attachment



Unstructured plastics, with “silky“ semi-gloss, or matt surface.

Applying a kind of cross hatch pattern:

→ 80 Cuts / 0,5 mm cutting distance / weight force: 7 N .

A defined Test Disc is guided about the surface to be tested, turned about 90° from the working direction.

Small cutting distance → Overlapping of the single traces.

Visual impression → More a homogegeous area than a pattern.

At accordingly sensitive surfaces:

→ Polishing effect.

= A change of the gloss (increasing).

→Gloss measurement with a Glossmeter,
with 60° measuring geometry.

→Comparison: Before / After.

Matt surfaces after polishing:

Caused by reduction of the diffuse light reflexion

→visually darker.

Glossmeter PICOGLOSS 560 MC

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For both methods (Scratch Resistance of leather type structured Plastics Materials as well as for the Writing Effect), the concerning car manufacturers uniformly use ERICHSEN Scratch Hardness Tester 430 P !

SCRATCH HARDNESS TESTER 430P-SMART

ERICHSEN Scratch Hardness Tester 430P-SMART :

Previously designed for cross hatch cutting.

But now, it is at more than 10 well-known car manufacturers the very first choice standard solution for scratch tests on plastics materials for car interiors.

It is also recommended by the VDA!

Subsequently, some partly since a lot of years well established testing equipment as well as its current advancement.

1. Hardness Rod 318

Model 318

ERICHSEN

The *new* Mod. 318 S

Model 318 S

2. Mar Tester 435

Model 435

The *new* Mod. 435 S

ERICHSEN

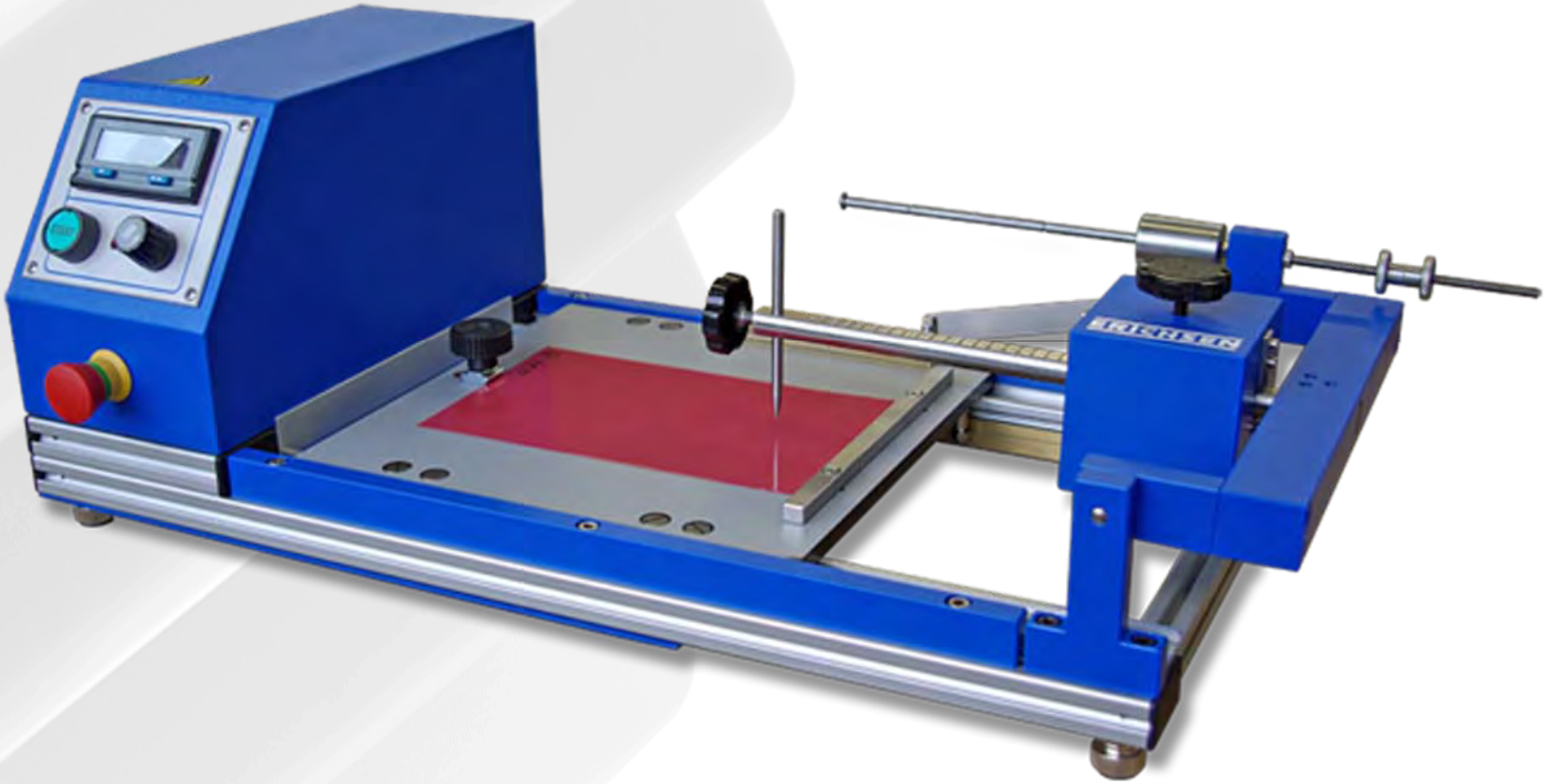
Model 435 S

ERICHSEN

The *new* LINEARTESTER 249

ERICHSEN

Model 249



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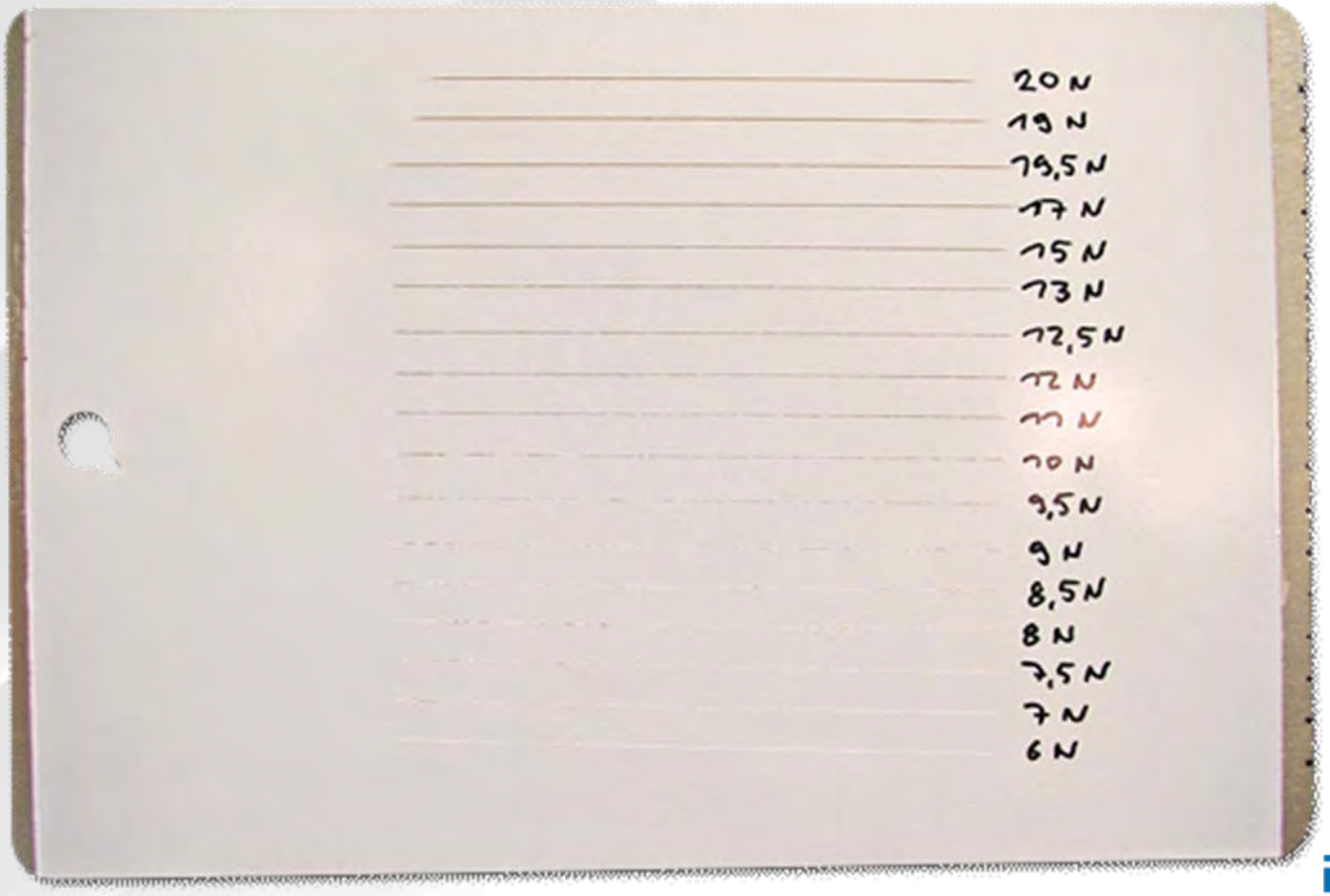
Scratches applied with 6 – 20 N



4. Scratch Hardness Tester acc. to. Wolff-Wilborn, Mod. 293 (“TriForce Pencil Hardness Tester“)

Model 293

ERICHSEN

Standards‘ stipulations should

be understood as an important

fundamentalpart of the testing matter.

Important Keywords of the testing matter:

→ Precision.

→ Repeatability.

→ Traceability to standards‘ stipulations.

Oftenly, some individual variation of the test method is necessary to get a useful representable spread of differences in the results.

In such case, the traceability to the valid standards‘ stipulations is no longer given/possible.

Due to this, it is prior urgent necessary to pay still high attention to precision and repeatability, when you go your own way, “on a modified path“.

An appointment of all parties involved in a testing matter, is meaningfull as well as necessary!

Also a brainstorming with a flexible manufacturer (☺) of testing equipment, has oftenly enabled the achievement of the best possible results.

Who knows, … possibly, in future your new modified test method will be stipulated by a new standard.

This would be not the first time.

Many thanks for your attention!

If there are any questions, please don‘t hesitate to ask!