Technical Bulletin

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NEW FINDINGS ON THE PASSIVATION LAYER OF STAINLESS STEEL SURFACES IN THE FIELD OF PHARMACEUTICAL EQUIPMENT

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The component's value is assured by its surface

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NEW FINDINGS ON THE PASSIVATION LAYER OF STAINLESS STEEL SURFACES IN THE FIELD OF PHARMACEUTICAL EQUIPMENT

While it has so far been widely known that stainless steel alloys form a more or less thin chromium oxide passivation layer under certain environmental and production conditions and that this is primarily responsible for the corrosion-resistant property of the surface, recent findings, particularly follow-up studies after cases of damage (primarily corrosion) have provided reason to investigate the phenomenon in more depth.

Auger and ESCS analysis methods, for relatively homogeneous structures, as well as the familiar EDX analysis supplemented by SEM measurements, for inhomogeneities (local inclusions), are suitable methods for investigating the structural composition of surface layers, i.e. the morphology.

While the first reports of this series explained in detail that electrochemically polished surfaces have the necessary morphological purity for homogeneous and stable chromium oxide passivation layers to form with relatively little interference, and that this is not possible with the same certainty for mechanically finished surfaces, the following findings were determined primarily on electrochemically polished surfaces of Mat. 1.4435 with an anodized polishing removal between 30 - 40 µm and a resulting peak-to-valley height of Ra = 0.2 - 0.3 µm.

The findings of the analysis generally show a typical morphological profile as in the included **Type sketch 1).** Here you can see that a chromium/iron weight ratio of 1.5:1 caused by the distinct chromium oxide formation can be determined on the immediate surface due to the special passivation process, although the underlying alloy has the familiar ratio of 0.3:1.

This typical and significant chromium/iron weight ratio of the chromium oxide layer decreases directly with the measurement depth and is reduced to the value of the underlying alloy 0.3:1 at approx. 50-60 Å depth.

This means that the anti-corrosive, primarily chromium-oxide-dominated matrix layer has a typical thickness of at least 20 Å (= 2 nanometer), with the chromium/iron weight ratio being 1.5:1 at the immediate surface and approx. 1:1 at a depth of 10 Å.

This significant iron- and therefore iron oxide-subdominant protective layer naturally also contains nickel and nickel oxide as well as molybdenum and molybdenum oxide and water molecules embedded by bridge bonding **(Type diagram 2)**.

This stable protective layer also suppresses ion formation, which is also significant for corrosion protection.

Measurements of corrosion potentials on surfaces of the described form show clear advantages in robustness in comparison to passivation layers with distinctly weaker formation.

Due to the dynamic character of such passivation layers, it is also important to compile findings on their breakdown, decay, and possibly also their new build-up in addition to their build-up and the parameters responsible for it.

A list of the influences and parameters responsible for the decay of the chromium oxide layer is indeed a list of the typical treatments and operating conditions that cause corrosion.

Knowledge of the described mechanisms is therefore a very helpful means for optimal handling and maintenance of stainless steel surfaces for problem-free operational use and can be a significant part of recurring cleaning, inspection, and passivation operations.

Please contact us for further information

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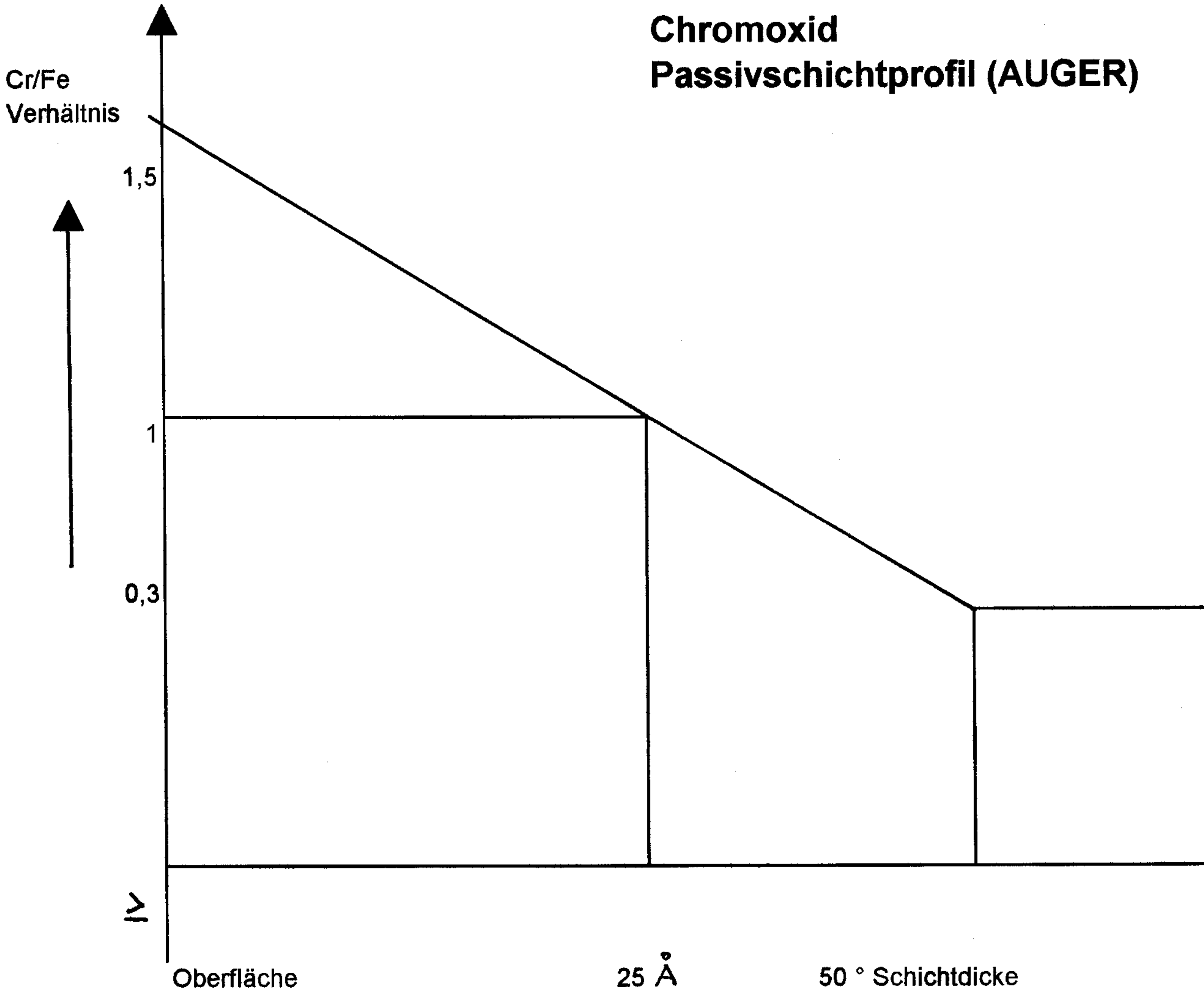
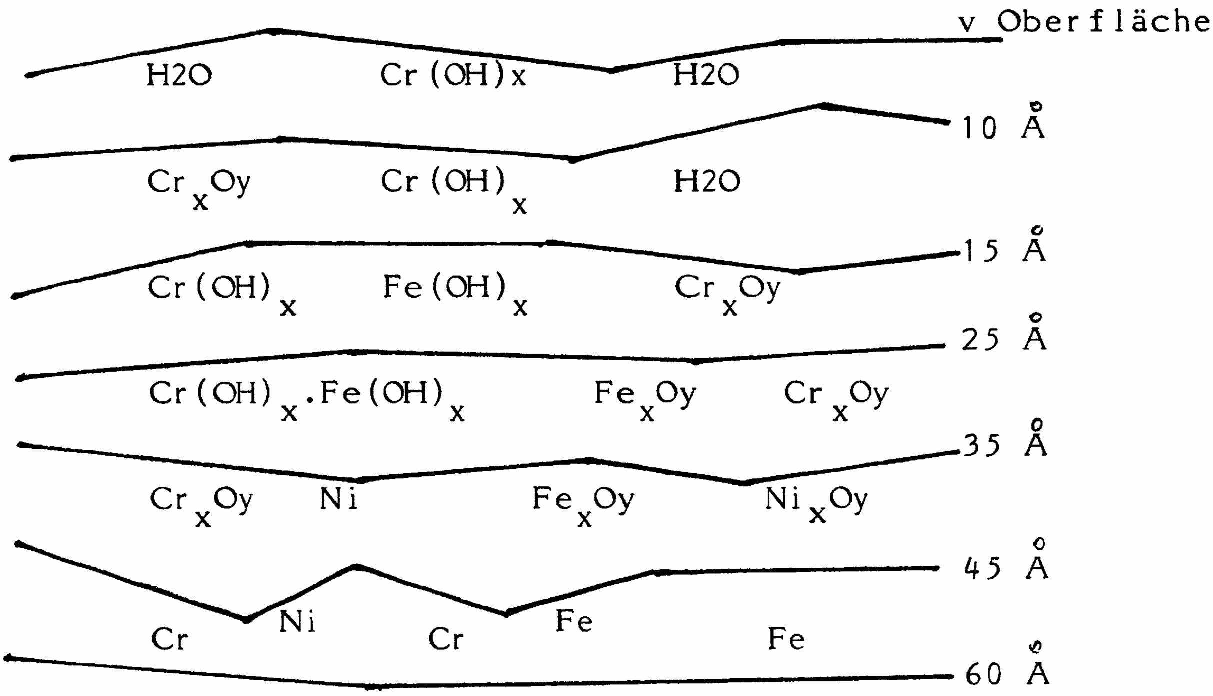
Sketch 1



Typdiagramm 1:

Sketch 2



Metall. Matrixgrundstruktur

Typdiagramm: 2

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- Electrochemical polishing
- Electrochemical and chemical deburring
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  - Copper
  - Niobium
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  - C-steel
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- concerning corrosion of stainless steel

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