第三章 表面层结构与性质

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3.1 The surface and the surface layer

3.1.2 The surface layer

technological surface layers

service generated surface layers

3.1 The surface and the surface layer

3.1.2 The surface layer

Superficial layer

below the physically pure surface
subsurface layer layers

superficial layer

3.1 The surface and the surface layer

3.1.2 The surface layer

Coating

situated above
the physically pure surface supersurface
layers

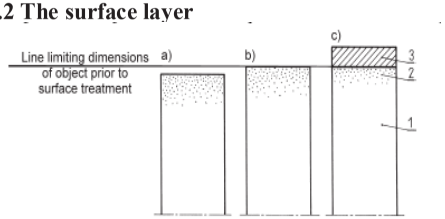
leading to a new layer

of a layer of new material,
different from that of the core

coating

3.1 The surface and the surface layer

3.1.2 The surface layer



Surface layers= superficial layer (a,b)
=superficial layer +coating(c)

3.2 Superficial layer and structure models

3.2.1 Superficial layer

surface

Beilby's layer

1. Definition of Superficial layer

includes _____ _____

2. Three aspects for the superficial layer

1) properties depend on the type of this treatment,

– spontaneously

– non-spontaneously

3.2.1 Superficial layer

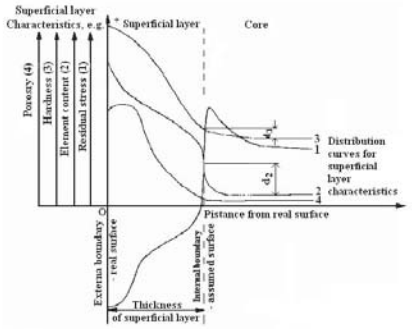
2) The superficial layer zone

性质

3) The internal limit of the superficial layer

_____

3. Determination of internal boundary of superficial layer.



4. Structure models of the superficial layer

- Specific characters of the solid surface

a certain state of unevenness

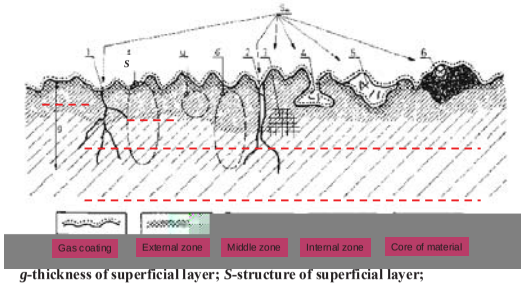
nascent atoms of the solid surface — high chemical activity

the formed superficial layer always has a structure not only but also

type conditions

the result of machining

The 3-zone model



g-thickness of superficial layer; *S*-structure of superficial layer;
u- strengthening of the middle zone;
σ - residual stresses in the superficial layer;
Sw-flaws of the superficial layer; *1*–micro fracture; *2*- fissure; *3*-microshrinkage; *4*-porosity; *5*–gap; *6*-inclusion

The 3-zone model

- external

0.001 to 0.02 μm

μ

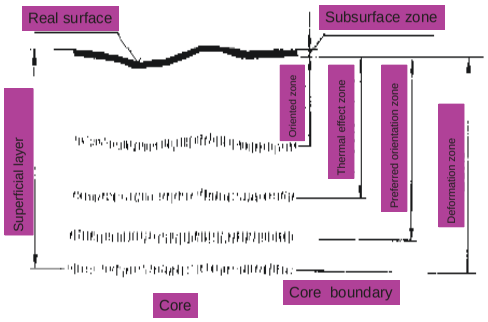
- middle — deformed grains

0.5 to 500 μm

- internal — not permanently deformed

several thousand micrometers

The 5-zone model



The 5-zone model

- subsurface

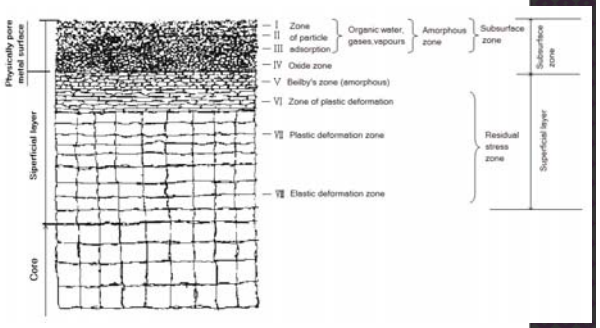
- directional constitutes a portion of the zone of deformation

- heat affected — a portion of the zone of deformation

- preferred orientation — constitutes a portion of the zone of deformation with a preferred crystal or grain orientation.

- zone of deformation — permanent deformation took place

The 8-zone model



The 8-zone model

Zone I

Zone II

Zone III

Zones I to III

Zone IV

The 8-zone model

Zone V — 造成

0.1 to 1 μm

Zone VI

not exceed several tenths of a millimeter

The 8-zone model

Zone VII

not exceed several tenths of a millimeter

Zone VIII

3.3 Potential properties of the superficial layer

3.3.1 Geometrical parameters :

asperities(粗糙，不平)　peaks　valleys

which are usually traces of treatment or wear

asperities

roughness　waviness (波度)　flaws(缺陷)

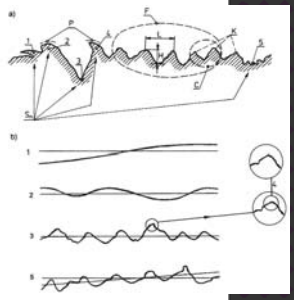
3.3 Potential properties of the superficial layer

3.3.1 Geometrical parameters :

a) The profile of asperities on surface of a solid　H　L　F　C　P　K　S_n

1　2　3　4　毛边　5

b) elements and resultant unevenness　1　2　3　4　5



3.3 Potential properties of the superficial layer

3.3.1 Geometrical parameters :

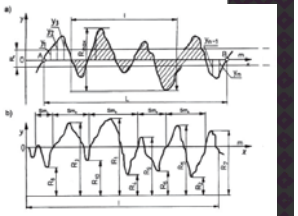
Surface roughness

$R_a = \frac{1}{n}\sum_{i=1}^{i=n}|y_i|$

R_a

R_z

the mean distance of five highest peaks to five lowest valleys



3.3 Potential properties of the superficial layer

3.3.1 Geometrical parameters :

- Structural flaws
-

（腐蚀，侵蚀；磨损）　弹坑

3.3 Potential properties of the superficial layer

3.3.1 Geometrical parameters :

- Structural flaws
- Defects

mechanical damage

chemical or erosive damage　hidden material flaws 暗伤；暗疵)

材料本身具有的 由于加工而暴露出来）

- Grooves(凹槽)

mating surface 配合表面

plastic stacking堆垛

倒角

3.3 Potential properties of the superficial layer

3.3.1 Geometrical parameters :

- Structural flaws
- Scratches(刮痕)
- Cracks
- Pores

the form of　裂缝　导管　槽　*in*　泡

3.3 Potential properties of the superficial layer

3.3.1 Geometrical parameters :

-

with the rise of loading level, relative movement velocity and accuracy

- deviation

3.3 Potential properties of the superficial layer

3.3.2 Stereometric-physico-chemical parameters

1)Emissivity -

Total emissivity $_T$　M

M_{bb}

hypothetical blackbody

Monochromatic emissivity $_\lambda$

$\varepsilon_T = \frac{M}{M_{bb}} = \frac{\int_0^\infty \varepsilon_\lambda M_{\lambda bb} d\lambda}{\int_0^\infty M_{\lambda bb} d\lambda}$　$\varepsilon_{\lambda 1} = \frac{m_{\lambda 1}}{m_{\lambda 1,bb}}$;　$\varepsilon_{\lambda 2} = \frac{m_{\lambda 2}}{m_{\lambda 2,bb}}$;　$\varepsilon_{\lambda n} = \frac{m_{\lambda n}}{m_{\lambda n,bb}}$

$\varepsilon = F\{\varphi(m), f[t_o, \ddot{U}_o, t_m, g_t, \vartheta(u, p, h)], \psi(n)\}$

m

t_o

^{o}

t_m

U_t

u

p

h

n

ξ　f

3.3 Potential properties of the superficial layer

surface roughness

physico-chemical condition of the emitting material

Example:
The relation of the emissivity of the metal to the roughness

metallic material

$\varepsilon_T = \varepsilon_{T(init)} + \Delta\varepsilon_T$

$\varepsilon_{T(init)}$

$\Delta\varepsilon_T$ **surface oxidation**
and surface unevenness

$\Delta\varepsilon_T$ $\varepsilon_{T(n)} + \varepsilon_{T(m)}$

$\varepsilon_{T(n)}$

$\varepsilon_{T(m)}$

- 楔形的 形的

cavities
triangular-shaped teeth

$$\varepsilon_{T(n)} = \varepsilon_{T(init)} \frac{W}{1+(W-1)\varepsilon_{T(init)}}; \qquad W = \frac{n_{w(t)}}{n_{w(init)}};$$

- W
- $n_{w(t)}$ t $n_{w(init)}$
- $$n_w = \sqrt{1+4\left(\frac{R_z}{S}\right)^2}$$
- R_z S

3.3 Potential properties of the superficial layer

-

All of these factors intensify with a rise of temperature

- **Greatest emissivity is exhibited by surfaces which are rough, matte(不光滑的), dark, oxidized and corroded**

3.3 Potential properties of the superficial layer

3.3.2 Stereometric-physico-chemical parameters

- **2) Reflectivity** R **-**
- ε_T R
- **Highest reflectivity for heat radiation is exhibited by surfaces which are smooth (polished), shiny and bright**