Sprayed titanium interaction with substrate material and interlayer influence onto titanium hydrogen saturation.

A. B. Sokolov, V. A. Syasin, V. N. Kruglov, I. A. Sviridov,

N. I. Borodina, I. K. Ponorets, A. D. Senchukov

FSUE VNIIA named after N. L. Dukhov, Moscow

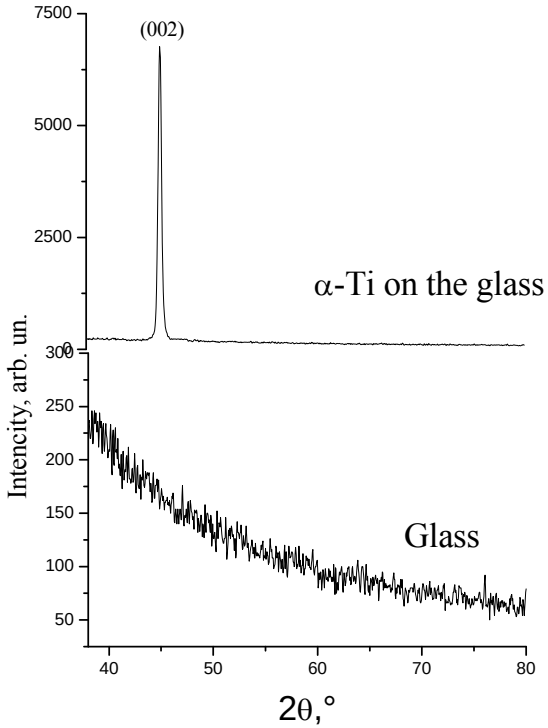
Outline

1. Substrate structure condition influence onto the texture of the sprayed titanium film.
2. Change of sprayed film structure condition as a result of hydrogen saturation.
3. Titanium-substrate interlayer formation.
4. Interlayer influence onto titanium interaction with hydrogen.

Substrate condition and the sprayed layer grain

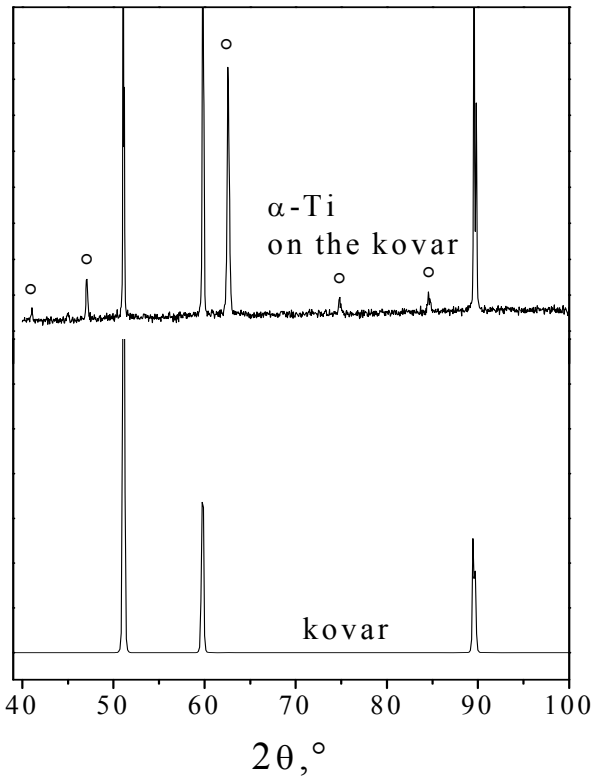
Substrate amorphous structure

Intensity, rel. units



Pyrex glass

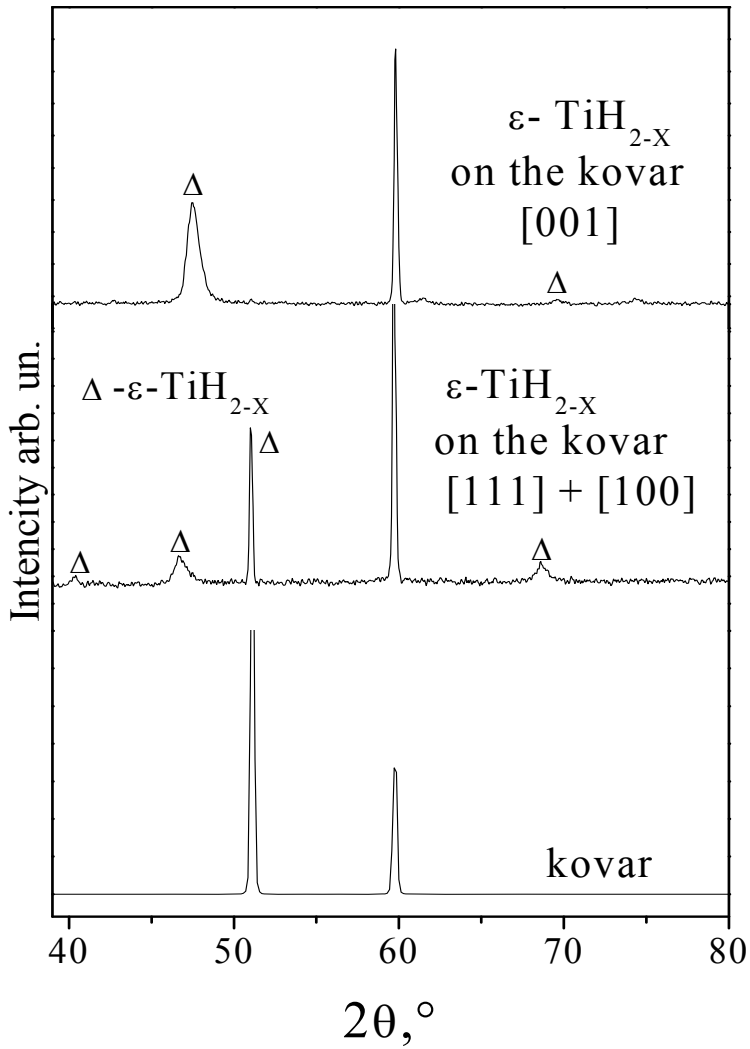
Crystalline face-centered cubic structure of the substrate



Kovar (Fe-50; Ni-30; Co-20 (% mass))

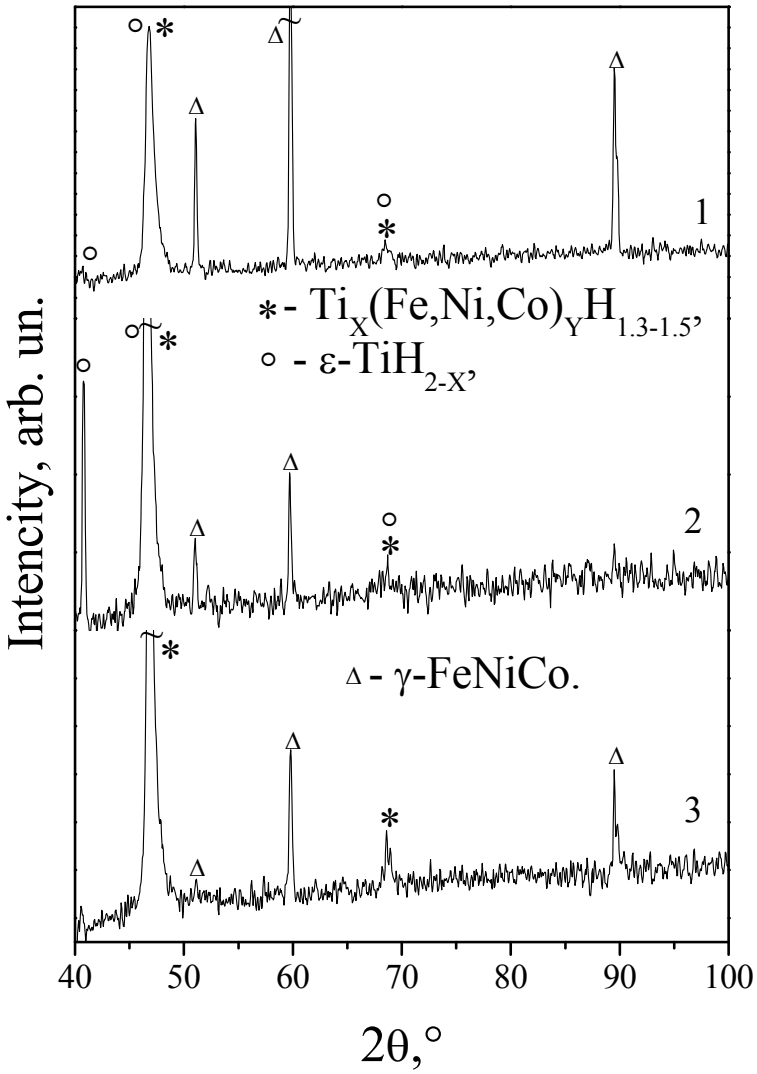
Coupling between substrate structure condition and the sprayed titanium film texture

Titanium sprayed film structure condition after hydrogen saturation



Titanium hydride film inherits sprayed layer texture.

Intermetallide and titanium hydrides formation.



500°C.
$Ti(Fe_XNi_YCo_Z)H_{1,3-1,.5}$ ~ 30 % ;
ε-TiH_{2-X} ~ 70 %

450°C.
$Ti(Fe_XNi_YCo_Z)H_{1,3-1,.5}$ ~ 5 % ;
ε-TiH_{2-X} ~ 95 %

550°C.
$Ti(Fe_XNi_YCo_Z)H_{1,3-1,.5}$ ~ 90 % ;
ε-TiH_{2-X} ~ 10 %

Equations

. The penetration depth

$$\mathbf{h \sim 2\,(Dt)^{1/2}} \qquad \mathbf{(1),}$$

where: **D** – diffusion coefficient,

t – time.

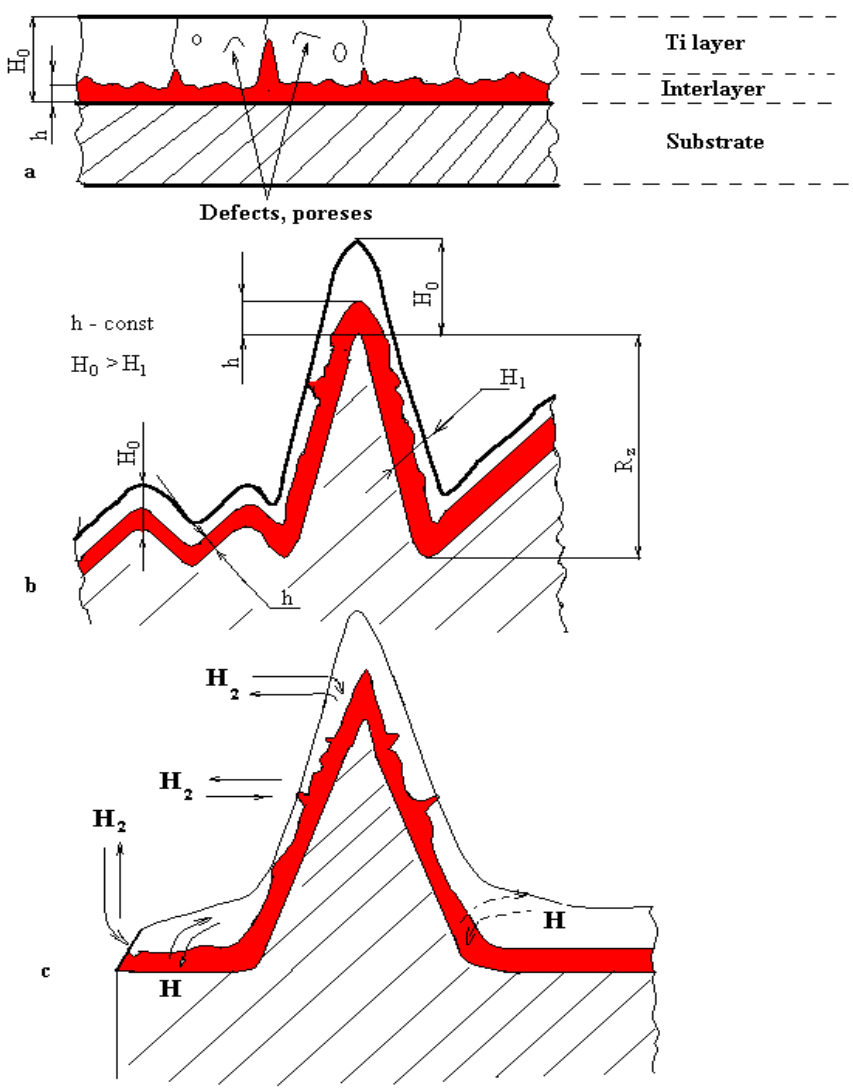
Temperature dependence of diffusion coefficient is determined by the following expression:

$$\mathbf{D = K_{eff}\, D_o \exp(-\Delta H/RT)} \qquad \mathbf{(2),}$$

where: ΔH – activation energy,

K_{eff} – coefficient, determined b the structure condition of the material.

“Substrate-sprayed layer” boundary structure diagram.



a –perfectly plain surface of the substrate;

b – substrate with rough surface;

c – possible ways of hydrogen migration.

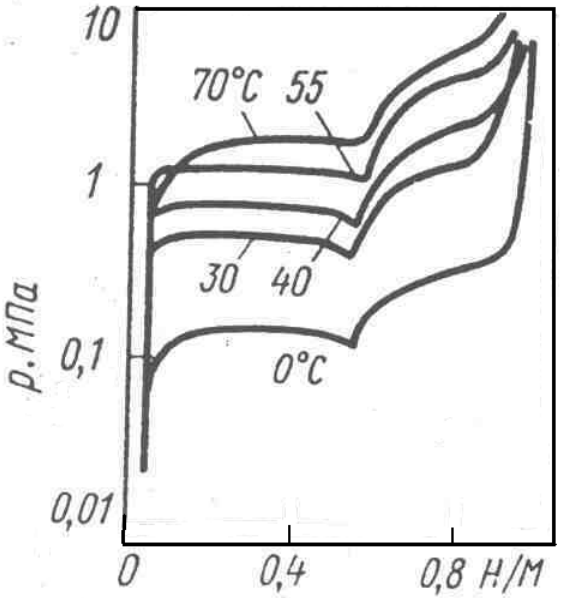
H_0 – original thickness of sprayed layer;

h – interaction layer (interlayer) thickness;

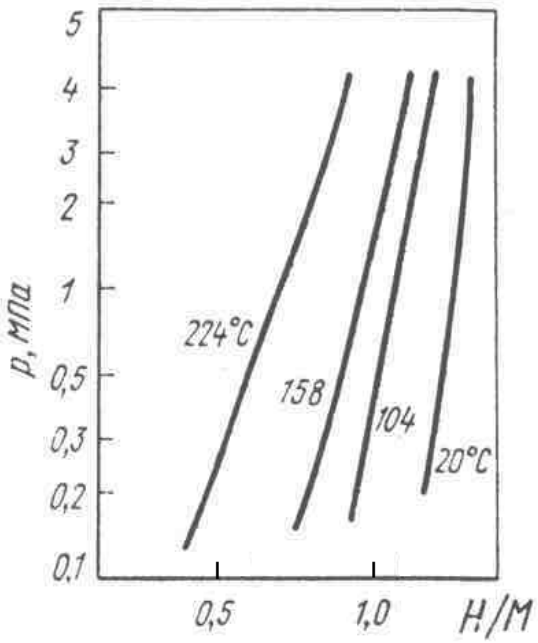
H_1 – original layer thickness on the asperity side face;

R_Z – asperity height (rough surface parameter).

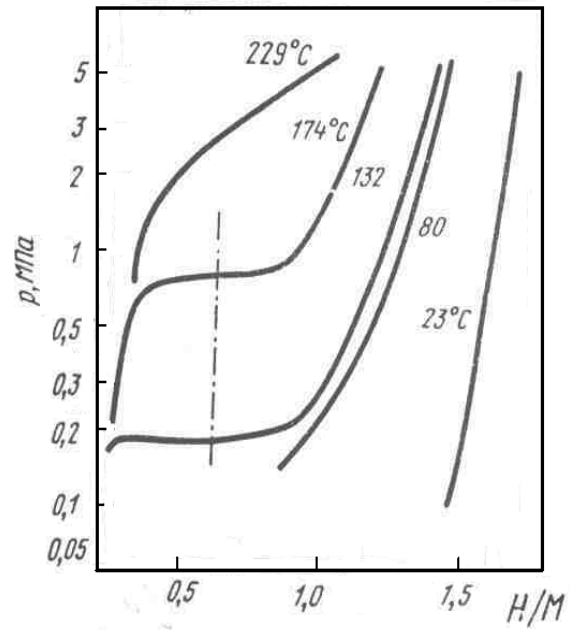
Hydrogen pressure isotherms [2]



TiFe-H



TiNi-H



TiCo-H

Conclusions

1. Substrate structure condition determines the sprayed titanium layer texture.

2. Hydrogen saturation of the texture titanium film leads to texture hydride film formation.

3. It is demonstrated that such effects as spraying temperature and value of the substrate effective surface have significant influence on the interlayer formation process in the system of kovar substrate-sprayed titanium.

4. The interlayer influences the hydrogen pressure equilibrium value upon sprayed and saturated titanium layer and, as a result, the process of the titanium film hydrogen saturation and hydrogen loss during thermal treatment.

Authors express their acknowledgement to S. P. Vorobyov, A. S. Khapov, J. K. Presnyakov, S. A. Komov for their attention to this work, for help in carrying out research and the discussion of results.

References.

1. V. Zait, Diffusion in metals, M. IIL, 1958.
2. B.A. Kolachev, R. E. Shalin, A. A. Ilyin, Hydrogen accumulators alloys, M., Metallurgiya, 1995.

Благодарю за внимание

Thank you for Your attention