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# RESIDUAL AUSTENITE ANALYSIS OF BEARING ELEMENTS

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**SUMMARY**
*Problems of occurred residual austenite owing to various material aspects can caused the dimensional changes. On the one hand there is the material, processing and chemical content, on the other hand is the following machining and heat treatment. By application of diffractometer analysis were evaluated the bearing elements like races and rollers tempered on two different temperatures .*

**Keywords:** steel, austenite, heat treatment, ball races

## 1. THEORETICAL ASPECTS

The heat treatment analysis inclusive the thermal stresses and deformations. In the technological praxis are occurred the cases when are detected the stresses which are able to crack growth creation. Some practical examples present the damage of product.
In term of time actuating there are separate the temporally inside stresses and the residually stresses.
The temporally inside stress influence while exists the inducing reason. There are presented causes of thermal field irregularity among the surface and inner parts, elastic deformation which is created by different locally dilatation, next can be presented the factor of inside stresses which is created by heating (cooling) process.
If the part of stresses is working then these are characterized as residual stresses. This cause is one of the more stresses which are inducing in articles. Following there are created by inhomogeneous strain and defined as the multi axial stress which affected in a part for long period. Then we can classify three reasons of residual stress.
*Thermal residual stresses* – there are induced by various thermal gradients (different thermal coefficients of tensibility) inside the part or structural elements.
*Deformed residual stresses* – occurred by machining, the surface layers are deformed more intensively than the inside parts of article. By the inside compression forces elimination are created the tensile stresses at the surface and compressive stresses inside the part.
*Structural residual stresses* – the inhomogeneous structural transformation is occurred by the volume changes (austenite → ferrite transformation, or volume differently transformations of austenite → martensite).
The corporate base of all stresses is the Hook law: $\sigma = E.\ \varepsilon$ (1)

The niveau of stress is assigned by elastic deformation size which is induced by volume changes in product. The term of inside stress is fully responsible to inside elastic deformation. Furthermore the stress is a function of Young modulus E.
In the next figure 1 we can observe the deformation steel dependencies.

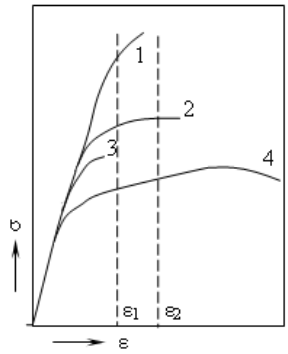


*Figure 1. Deformation steel dependencies; 1 – quenched, 2 – tempered, 3 – quenched of a high temperature, 4 - annealed*

The level of inside stresses induced by deformation ε1 is applied by breakage in case the steel quenched of high temperature. The increasing deformation – level of ε2 causes the failure in classical quenched steel. More plastically ability of tempered and annealed steel decreases the steel inclination to the cracks growth creation.

The presence of residual stresses has the narrow connection with a negatively properties affection of product. By welding and casting processes are created the cracks which induced the product deformation. Residual stresses cause the change the electrochemical potential and consequently occur to corrosion resistance decreasing and expanding the menace of stress corrosion. Besides the residual stresses can affected the electrical or magnetically properties. The main purpose of technology is to obtain such product with such structure the corresponded to requirements on mechanical a physical properties without the presence of residual stresses, or eliminate these residual stresses on the acceptable niveau.

## 2. EXPERIMENTAL PART

The mentioned samples were evaluated for residual austenite content by two elements (races, rollers). These samples were martensite quenched and next tempered on 240 °C or tempered on another value of temperature – 180 °C.
For material analysis was used the Diffractometer Philips, on the figures 2-5 are illustrated the diffraction analyses measurements of individual elements.
The content of residual austenite was calculated by following formula

$$w_A = \frac{\frac{I_A}{B_A}}{\left(\frac{I_A}{B_A} + \frac{I_M}{B_M}\right)} \cdot 100 \qquad (\%) \qquad (2)$$

Where $I_A$ and $I_M$ are the integral intensities of diffraction maximum corresponding to austenite and martensite planes (200); the $B_A$ and $B_M$ are intensity factors appertained to phases.

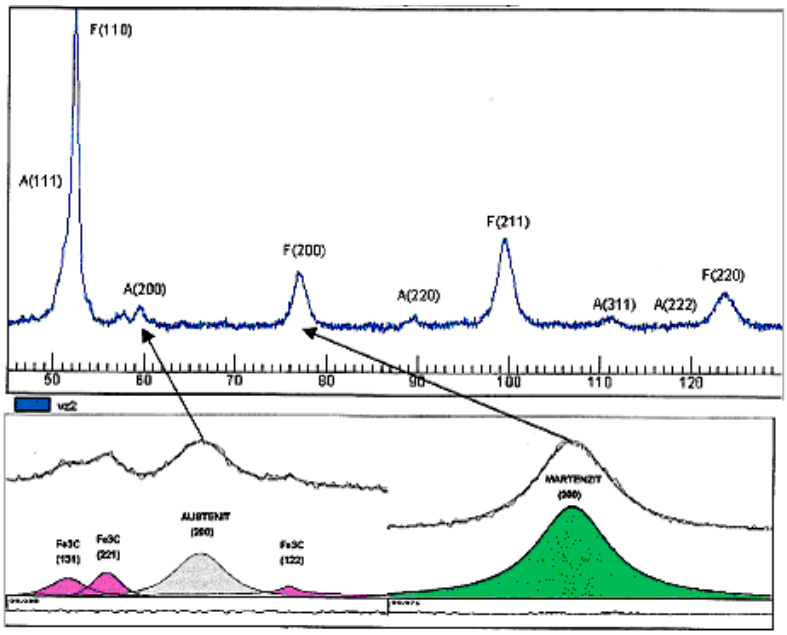


*Figure 2. Diffraction image of analysed sample (race) with details of measured diffraction maximums; martensite quenched and tempered on 240°C*

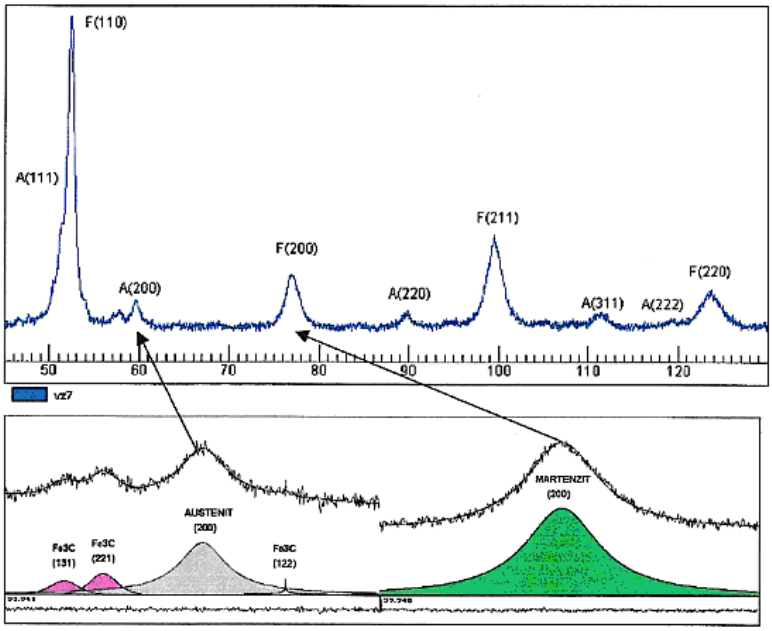


*Figure 3. Diffraction image of analysed sample (race) with details of measured diffraction maximums; martensite quenched and tempered on 180°C*

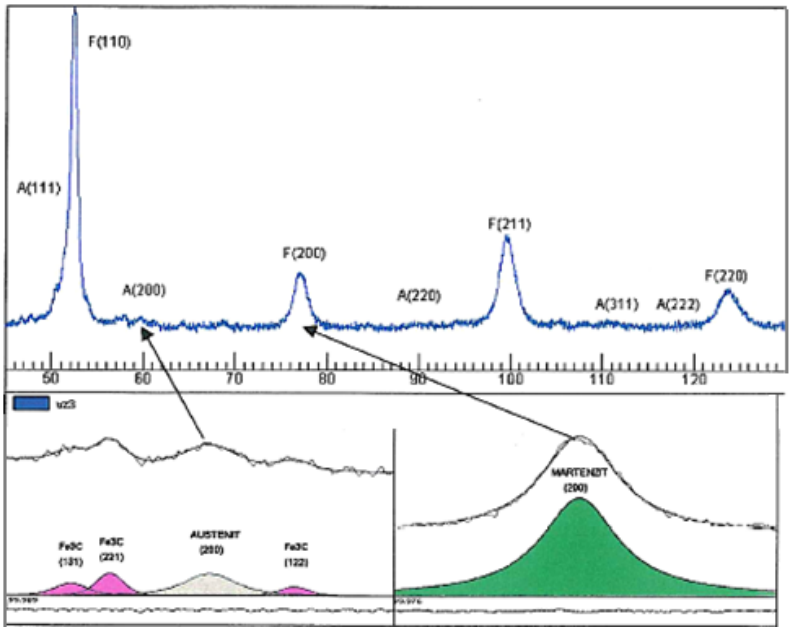


*Figure 4. Diffraction image of analysed sample (roller) with details of measured diffraction maximums; martensite quenched and tempered on 240°C*

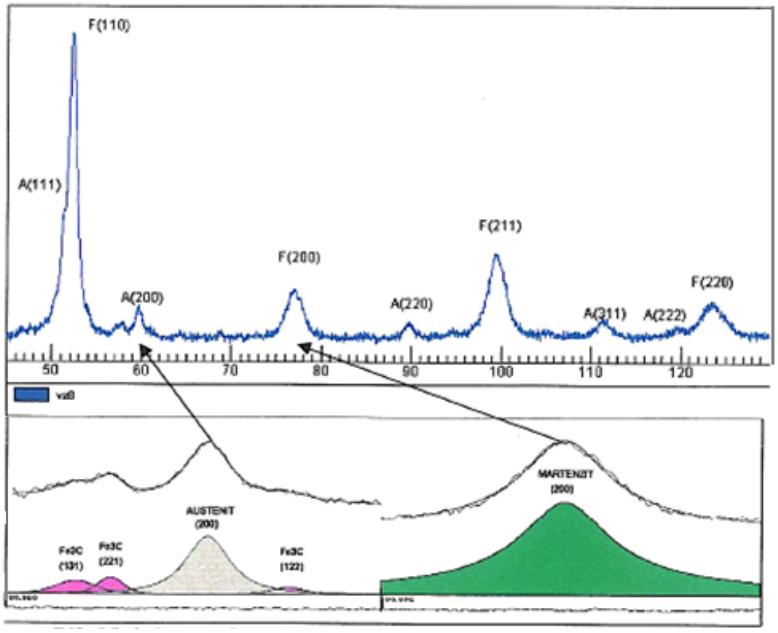


*Figure 5. Diffraction image of analysed sample (roller) with details of measured diffraction maximums; martensite quenched and tempered on 180°C*

## 3. CONCLUSION

The integral intensity (table 1,2) was analyzed by using of diffraction curves and estimated by the position of diffraction maximums. Besides the residual austenite and martensite there were identified also the chromium carbides $Cr_7C_3$ and iron carbides $Fe_3C$.
From the tables 1,2 we can allege that the higher content of residual austenite has race with lower tempering temperature. In case of another temperature (240°C) the residual austenite content was reducing. The situation is similarly by testing of roller samples. But in this case is noted the decreased content of residual austenite for both cases. For this experimental datas is possibly the influence of the machining processes or different chemical content opposite the prescribe values.

*Table 1.Measruered integral intensities for race samples*

| Integral intensity of diffraction maximum (2Θ.imp/s) | | | |
|---|---|---|---|
| Race martensite quenched and tempered on **240**°C | | Race martensite quenched and tempered on **180**°C | |
| plane (200) – austenit | plane (200) – martenzit | plane (200) – austenit | plane (200) – martenzit |
| 131 | 742 | 223 | 752 |
| Residual austenite content | | Residual austenite content | |
| 7,89 ± 1,14 % | | 12,51± 2,08 % | |

*Table 2.Measruered integral intensities for roller samples*

| Integral intensity of diffraction maximum (2Θ.imp/s) | | | |
|---|---|---|---|
| Roller martensite quenched and tempered on **240**°C | | Race martensite quenched and tempered on **180**°C | |
| plane (200) – austenit | plane (200) – martenzit | plane (200) – austenit | plane (200) – martenzit |
| 62 | 833 | 183 | 955 |
| Residual austenite content | | Residual austenite content | |
| 3,41 ± 0,84 % | | 8,46± 1,89 % | |

## 4. REFERENCES

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