SIMS analysis of hydrogen content in near surface layers of AISI 316L SS after electrolytic polishing under different conditions

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Abstract

Hydrogen concentration in AISI 316L stainless steel samples was monitored perpendicularly to the flat sample surface up to the depth of 0.8 μm, using secondary ion mass spectrometry (SIMS). Depth profile analysis was performed on the samples after electrolytic polishing under different conditions. Analyses were performed on SAJW-05 apparatus with quadrupole Balzers QMA-410 analyzer and Physical Electronics 06-350E ion gun. 5 keV Ar+ primary ion beam of 100 μm diameter was scanned over 1 mm × 0.8 mm area. Positive (H+, C+, CH+, O+, Cr+, Fe+) and negative (H−, C−, CH−, O−, OH−, CrO−, FeO−) secondary ion emission was registered from central part of the scanned area (10% of area) during primary ion beam sputtering. Results of hydrogen depth profile analysis were compared for the samples after a conventional electrochemical polishing (EP), and magnetoelectropolishing (MEP). Both EP and MEP processes were carried out under the electrochemical conditions regarding also natural and forced convection. The steel samples taken of a hot-rolled sheet, as received (AR), and after abrasive polishing (MP), were used as a reference. Results show that the increased current density (up to 200 A/dm2) and electrolyte stirring during electropolishing cause lowering of the hydrogen content in the samples, with the best result regarding hydrogen content decrease obtained on MEP200 sample. In fact, within the MEP process, characteristic with the self-contained electrolyte whirling, the contents of hydrogen are significantly decreased.

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1. Introduction

Electropolishing is one of the main technological processes advised for surface finishing of stainless steels [1–5]. This not only removes the deformed layer and improves surface roughness but also forms a very effective, thin passive film on the surface. High surface quality specifications such as surface smoothness, material cleanliness, hydrophilicity, and corrosion resistance were set by the semi-conductor and biomedical industries for their components [6].

The discussed surface properties, specifically the passivity and corrosion behavior of metals and alloys, may be further improved by introducing the magnetic field to EP process [7–23]. By patenting, the new process has been known as the magnetoelectropolishing MEP [24].

Our earlier studies indicated the advantageous increase of the Cr: Fe ratio in AISI 316L samples after MEP [8–11,13,14,18], much higher than in the samples after conventional EP. In our study on MEP with other materials, such as titanium and/or NiTi alloys [5,18–20,22], we could notice an improvement in mechanical properties, such as increase in fatigue resistance. In the work [25] we have presumed, that it may be the hydrogen content which is responsible for that varied mechanical behavior. Now we have concluded to carry out a primary research of the surface film composition concerning hydrogen content after metal surface treatments by EP and MEP. Hydrogen evolution and its ingress into metal surface has been a major problem studied for years [26–38].

It has been known that the hydrogen evolution and entry into iron and steel are strongly enhanced by renewal of the metal surface; e.g. during rapid scratching under potential control, both anodic and cathodic reactions are greatly accelerated [27,28,30]. Transients of enhanced hydrogen pressure through metal after potential jumps from cathodic to anodic polarization can result not only from an acidification, but also from the formation of oxides/hydroxides which may catalyze hydrogen electrode reaction (HER) and promote hydrogen entry [25,28].

It is common knowledge that a properly performed EP process is the best way to improve multiple metal surface properties, and also mechanical properties such as e.g. fatigue resistance [20,22,25]. One drawback of the EP process has existed up to now, namely adsorption of atomic H from electrolyte, which is created during the process on the cathode surface [25,39] and generates hydrogen embrittlement. The authors assume that H adsorbs at the cathode in a nascent
uncharged or atomic form after normal cathodic release from electrolysis, and then via some mass transfer process a portion of this non-ionic atomic H is transported through the solution, some of it, being non-ionic, is able to adsorb to the anode and diffuse into the lattice. That might be the reason of a change in metal properties after EP and MEP processes [25].

The MEP process overcomes hydrogen diffusion into the metal surface during EP by performing it in constant uniform magnetic field, the main difference in these two processes. Considering the electrolysis phenomena, the authors hypothesize that the magnetic field repels diamagnetic H and by this action in some extent prevents it entering into the metal lattice structure. The bending tests, carried out by the authors on biomaterials both titanium [19] and NiTi alloys [5,22,25] have shown that magneto electropolished wire samples endured from 20% up to 40% more bending cycles than conventionally electropolished ones. The improvement of mechanical fatigue behavior of MEP against EP endodontic files has been confirmed on finished by us samples by another team of authors [38] who performed the experiments with dynamic bending tests. A bigger number of studied samples (57 in total) allowed one to reveal a considerable shift indicating increased endurance of MEP vs. EP ones. All the above changes were achieved by applying a magnetic field to the EP process. Such results induced the authors to carry out the investigation on other biomaterial, AISI 316L, which seems to be less prone to hydrogenation.

Secondary ion mass spectroscopy (SIMS) is one of the few surface-sensitive analytical techniques available for the measurement of depth distributions of hydrogen in solids [26]. In SIMS, the surface of the specimen is sputtered, i.e. bombarded with an energetic ion particle, and surface layers are eroded as neutrals and ions. Secondary ions are emitted from the top one or two monolayers of the sample. Collection and analysis of the sputtered ionic species, i.e. secondary ions, provides an indication of the atomic and molecular structure of the material removed. Secondary ion currents do not represent atomic concentrations in a straightforward way, due to so called “matrix

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Results of elemental analysis of bulk AISI 316L SS samples, wt.% (Spectrolab M10 was used for the studies).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element C Si Mn P S Cu</td>
<td>Content 0.02 0.39 1.30 0.032 0.011 0.28</td>
</tr>
<tr>
<td>Element Cr Ni Mo W V Co</td>
<td>Content 16.92 10.38 2.01 0.04 0.09 0.19</td>
</tr>
<tr>
<td>Element B Al Sn N Fe</td>
<td>Content 0.0019 0.007 0.014 0.0405 Balance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Negative secondary ion current ratios $I_{H^-}/I_{CrO^-}$ and $I_{H^-}/I_{FeO^-}$ extracted from SIMS spectra of the three samples MP, EP and MEP50.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>$I_{H^-}/I_{CrO^-}$</td>
</tr>
<tr>
<td>MP</td>
<td>730</td>
</tr>
<tr>
<td>EP</td>
<td>9960</td>
</tr>
<tr>
<td>MEP50</td>
<td>303</td>
</tr>
</tbody>
</table>

Fig. 1. SIMS spectrograms of AISI 316L stainless steel samples: MP, EP and MEP50. Negative secondary ions were registered in 0–100 a.m.u. range.
effects” [40]. Also several other effects, like lateral and inward atomic relocations, due to ion bombardment [41,42], cause errors in description of concentration distributions.

The aim of this study is to perform hydrogen content analyses of austenitic AISI 316L stainless steel perpendicularly to the flat sample surface after a conventional electrochemical polishing (EP), and magnetoelectropolishing (MEP). Both EP and MEP processes were carried out under the electrochemical conditions regarding also natural and forced convection. The results are compared with the ones obtained on the steel samples taken of a hot-rolled sheet, as received (AR), and after abrasive polishing (MP), serving as a reference.

2. Method

2.1. Material and sample preparation

The composition of the AISI 316L austenitic stainless steel studied is presented in Table 1. The samples were cut off from a cold-rolled metal sheet of austenitic steel after plate rolling so that the austenitic structure was retained.

Three sets of austenitic stainless steel samples of dimensions 10 × 10 × 1 mm have been prepared for the investigation. For the hydrogen SIMS analyses, two series of samples were prepared:

(a) First series: MP, EP, MEP50
(b) Second series: AR, MEP200, MIX.

Samples prepared for the first series (a) were: MP, EP, and MEP50, with the first one, covering the mechanically polished (MP) samples prepared with SiC abrasive papers of final grit size of 1000, serving as a reference. The second one was electropolished (EP) under natural convection (in still electrolyte) in the transpassive region at the anodic current density \( i = 50 \, \text{A/dm}^2 \) [15]. The third set of samples in this series (MEP50) was treated by electropolishing using a magnetic field of intensity \( B \) of about 350 mT, leaving all other conditions unchanged.

Samples prepared for the second series (b) were: AR, MEP200, and MIX, with AR referring to the samples obtained straight after cutting them off from the same metal sheet. MEP200 refers to the samples electropolished in the magnetic field under the following conditions: \( i = 200 \, \text{A/dm}^2 \), \( B = 350 \, \text{mT} \). MIX refers to electrolytically polished samples obtained in the EP process \( (i = 200 \, \text{A/dm}^2) \) under the electrolyte moderate stirring.

The set-up used for MEP and electrolyte composition, the same employed for EP and MEP, were presented in many previous authors’ works [3,5–20,22].

2.2. Apparatus and surface analysis

For the hydrogen content studies, the SIMS analysis was carried out using a device of model SAJW-05 [43,44]. Base pressure in analytical chamber of SAJW-05 is 1 × 10^{-10} Torr. The Ar\(^+\) ion gun of

![Fig. 2. SIMS spectograms of AISI 316L stainless steel samples: MP, EP and MEP50. Positive secondary ions were registered in 0–120 a.m.u. range.](image-url)

Table 3

<table>
<thead>
<tr>
<th>Sample</th>
<th>( \frac{I_{H^+}}{I_{Cr^+}} )</th>
<th>( \frac{I_{H^+}}{I_{Fe^+}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP</td>
<td>0.196</td>
<td>0.291</td>
</tr>
<tr>
<td>EP</td>
<td>0.511</td>
<td>0.472</td>
</tr>
<tr>
<td>MEP50</td>
<td>0.510</td>
<td>0.475</td>
</tr>
</tbody>
</table>
energy 5 keV and current 1.8 μA was used. The introductory SIMS measurements, relying on the recording of mass spectrums at the stationary beam of the primary ions, were carried out. During the recording of one spectrums, with no scanning of primary ion beam, the etched crater 1 μm deep was done. Depth of eroded craters was monitored ex-situ by stylus profilometry (Taylor Hobson). During depth profile analysis, primary ion beam was scanned and emission of the secondary ions coming out of the central part, 10% of the sputtered area, was registered during the analysis. Resulting sputtering rate in scanning mode was 18 nm/min.

3. Results

The study results were performed for the comparison of hydrogen contents in the surface film of the same AISI 316L austenitic stainless steel. The samples differed with the kind of surface treatment and referred to two series, with three sets in each of them.

3.1. SIMS analysis of the first series

3.1.1. SIMS mass spectra (negative secondary ions)

The results of SIMS were performed on three differently prepared AISI 316L steel samples, MP, EP, and MEP50, with mass spectrums presented in Fig. 1. Negative secondary ions were registered in the range of 0–100 a.m.u.

The reference sample (MP) is characteristic with a more rich spectrum of ion currents in comparison with the spectra obtained on samples treated by EP and MEP50 (Fig. 1). This testifies of a greater contamination of the MP sample surface and of its higher roughness in comparison with the electrochemically polished ones.

The values of the secondary ion currents have been registered during the record of spectrums serving to evaluate the emission of hydrogen ions in comparison with the emission of secondary ions coming from the basic components of steel. The current proportions of the H⁻ ions to the CrO⁻ and FeO⁻ ion currents have been calculated (Table 2).

Table 2 presents results obtained during registration of mass spectra. In this case no primary ion beam scanning is applied and results consider crater edge effects, so they should be treated only as a rough indication of possible differences. Depth profile data, presented below, are registered with primary beam scanning, and detection of secondary ions emitted from the center of a crater.

3.1.2. SIMS mass spectrums (secondary positive ions)

SIMS positive secondary ion emission was measured on three differently prepared AISI 316L steel samples, MP, EP, and MEP50, results are presented in Fig. 2. The positive secondary ion currents were registered in the range of 0–120 a.m.u.

Fig. 3. SIMS (+) depth profile analysis results. Positive secondary ions H⁺, C⁺, CH⁺, O⁺, Cr⁺, and Fe⁺ were recorded. Etching time of 50 cycles corresponds with the etching depth of about 1 μm.

Fig. 4. SIMS (−) depth profile analysis results. Negative secondary ions H⁻, C⁻, CH⁻, O⁻, OH⁻, CrO⁻, and FeO⁻ were recorded. Sputtering depth range was about 1.5 μm.
Also, the proportions of currents of H\(^+\) ions to the currents coming of Cr\(^+\) and Fe\(^+\) ions have been calculated (Table 3). Hence, no differences in \(I_{H^+}/I_{Cr^+}\) and \(I_{H^+}/I_{Fe^+}\) ratios have been noticed between EP and MEP50 samples, the ratios in reference sample MP are much lower.

During depth profile analysis 5 keV Ar\(^+\) primary ion beam is digitally rastered over an area of 1 × 0.8 mm. Depth of eroded craters was monitored \textit{ex-situ} by stylus profilometry (Taylor Hobson). The resulting sputtering rate was 18 nm/min. Emission of the secondary ions coming out of the central part, 10\% of the sputtered area, is registered during analysis. Several masses of secondary ions have been selected to sequential measurement of ion currents during sputtering:

(a) positive ions: H\(^+\), C\(^+\), CH\(^+\), O\(^+\), Cr\(^+\), Fe\(^+\) (Fig. 3), and
(b) negative ions: H\(^-\), C\(^-\), CH\(^-\), O\(^-\), OH\(^-\), CrO\(^-\), FeO\(^-\) (Fig. 4).

Figs. 3 and 4 show positive and negative secondary ion currents, respectively, recorded versus sputtering depth. A steeper change/ decrease in both monoatomic hydrogen ions and molecular hydrogen ions on EP and MEP50 in comparison with the ions on MP samples, may be observed.
The choice of secondary ions has been done to compare the hydrogen containing ion emissions with the emission of the ones not containing hydrogen. Positive secondary ion emission ($I_{\text{H}^+}$ and $I_{\text{Fe}^+}$) changes up to the depth of 1 $\mu$m for three studied samples. $I_{\text{H}^+}/I_{\text{Fe}^+}$ ratios of EP sample are about 2.8 times higher than the ratio of MP sample. $I_{\text{H}^+}/I_{\text{Fe}^+}$ ratio of MEP50 scales between EP and MP samples – see Fig. 5. These results are to serve for an exemplary normalization of the SIMS depth profile data with the aim to determine distributions of element concentrations. They are presented for the sputtering depth of about 1.5 $\mu$m.

Negative SIMS depth profile analysis results (Fig. 4) served to compare the emission of hydrogen monoatomic ions and molecular ions containing hydrogen (Fig. 6). In the graph a big decrease in $I_{\text{H}^-}/I_{\text{FeO}^-}$ ratio in MEP50 sample is noticed in comparison with the ratio detected on EP and MP samples. Two another current ratios, $I_{\text{C}^+}/I_{\text{FeO}^-}$, and $I_{\text{OH}^-}/I_{\text{FeO}^-}$, regarding molecular hydrogen, are also in favor of MEP50 sample, though in the case of $I_{\text{OH}^-}/I_{\text{FeO}^-}$ with a minor difference.

Two more dependences of $I_{\text{C}^+}/I_{\text{C}^-}$, and $I_{\text{OH}^-}/I_{\text{O}^-}$ against ion etching time were obtained on the MP, EP, and MEP50 samples (Fig. 7). The results, concerning further molecular hydrogen ratios, also indicate decreased values on MEP50 samples, in comparison with the ratios on MP and EP samples.

### 3.2. SIMS analysis of the second series

The analyzed samples in the second series were: AR, MEP200, MIX. Profile analysis was carried out concerning three samples by monitoring positive ion current intensities of $^1\text{H}^+$, $^1\text{H}_2^+$, $^{16}\text{O}^+$, $^{52}\text{Cr}^+$, $^{56}\text{Fe}^+$ and $^{58}\text{Ni}^+$ during etching of craters up to about 0.75 $\mu$m deep. It was assumed that the etching rate was 18 nm/min. Mass spectrograms were performed in the range of 0–100 a.m.u. (Fig. 8) and the depth profile analyses are presented in Figs. 9, and 10.

Ion current ratio of hydrogen ions to main steel component ions i.e. iron and chromium ions ($I_{\text{H}^+}/I_{\text{Fe}^+}$), can be treated as a measure of hydrogen concentration in steel. Obtained SIMS depth profiles are presented in Fig. 10, assuming that after sputtering of 0.75 $\mu$m, hydrogen concentration reaches steady bulk value, the same in all three samples. Though the contents of particular ions vary from sample to sample, the change in monoatomic $\text{H}^+$ ions is much steeper in electropolished samples than that in AR. That may mean a decrease in the level of hydrogenation of electropolished samples just under first monolayers, in comparison with AR sample.

Finally, SIMS depth profile analysis of hydrogen concentration in at.% in all six analyzed samples (two series) is presented in Fig. 11. In this analysis it was assumed that bulk concentration of hydrogen in AISI 316L steel is 56 at.ppm [45] and that bulk value of hydrogen concentration is reached after sputtering to the depth of 0.75 $\mu$m. These results are presented in two pictures: (a) showing the hydrogen concentration in a linear dependence on depth, and (b) revealing this change in the logarithmic scale.

As a result of inward atomic relocations during 5 keV Ar bombardment, hydrogen distribution in analyzed samples is disturbed. The values of the $I_{\text{H}^+}/I_{\text{FeO}^-}$ ratio would drop at lower depths, if we could exclude inward relocations. In our measurements, sputtering conditions are the same for all analyzed samples, so inward sputtering...
occurs also in each case. In fact, we see definite differences in depth profiles, showing real differences in hydrogen distributions dependent on the way of electropolishing procedure applied.

4. Discussion

The work presents an attempt to find a way of assessing the potential presence of hydrogen resulting for different kinds of surface treatment. The focus is to apply SIMS as a method for determining the hydrogen. As such, this is a viable method to find small amounts of hydrogen in a surface, but the analyses are influenced by several factors and the proper determination of hydrogen by means of SIMS is not a simple task.

We present SIMS depth profile analysis of several secondary ions, atomic and molecular, positive and negative, in order to characterize hydrogen presence in the near surface layers and monitor the levels of external sources of contamination as vacuum environment, analytical gas purity and surface contaminations, like hydrocarbons of the measured samples. The applicability of SIMS for assessing the levels of hydrogen in the surfaces of the samples studied appeared to be fully
I consider the negative ions are different. Also in the case of positive ions we show that matrix effects for positive and negative metallic ion emission (Figs. 3, 5 and 9), showing differences in concentration distributions and also pointing out that concentration of these molecules decreases with increasing depth. The best results concerning hydrogen concentrations are related to MEP200 sample in comparison with two others (AR, MIX). Moreover, the big discrepancy in the current ratios in the samples after electropolishing operations (MEP200, MIX) may indicate a probable dynamic behavior in the hydrogen monoatomic ions tending to form 
\( \text{H}_2 \) molecules.

The results of SIMS analyses carried out on AISI 316L stainless steel indicate that the hydrogen concentration in perpendicular direction to the studied surface varies from sample to sample. An interesting regularity is observed with the results depending on the way of preparation of samples. Very big differences in hydrogen contents may be observed in the subsurface layer up to 50 nm, independent on the sample preparation method; then, going deeper, these differences are getting smaller, reaching their bulk values at a depth less than 1 \( \mu \text{m} \) from the top.

In the SIMS studies both negative and positive secondary ions were registered (Figs. 1, 2, and 8, and Tables 2, and 3). The most striking are differences in the negative secondary ion current ratios \( I_{\text{H}}/I_{\text{CO}} \) and \( I_{\text{H}}/I_{\text{O}} \) extracted from SIMS spectra (Table 2). Assuming MP sample as a reference, the ratio \( I_{\text{H}}/I_{\text{CO}} \) was over two times lower for MEP50 and over thirteen times higher for EP sample. The ratio \( I_{\text{H}}/I_{\text{O}} \) was also over two times lower for MEP50 and over four times higher in EP sample. In case of positive secondary ion currents, the ratio \( I_{\text{H}}/I_{\text{Fe}} \) is about 2.6 times lower for MP sample than for EP and MEP50 samples. The ratio \( I_{\text{H}}/I_{\text{Fe}} \) is about 1.6 times lower for MP sample than for EP and MEP50 samples, whereas there is no noticeable difference in the current ratios \( I_{\text{H}}/I_{\text{C}} \) and \( I_{\text{H}}/I_{\text{O}} \) between EP and MEP50 samples, respectively.

From Figs. 3–6 one may note that the currents of hydrogen monoatomic ions are lower in MEP50 in comparison with the currents in EP sample. Much less difference in currents is observed between molecular ions containing hydrogen (Figs. 3, and 5), though in the case of the ratio \( I_{\text{H}}/I_{\text{FeO}} \) (Fig. 6) it is in the advantage of the MEP50 sample.

Hydrogen ratios ‘rank’ different in these two cases. Presenting the data of Figs. 4 and 6 we show that matrix effects for positive and negative ions are different. Also in the case of positive ions we consider the \( I_{\text{H}}/I_{\text{Fe}} \) ratio and in the case of negative ions \( I_{\text{H}^-}/I_{\text{Fe}^-} \) is considered, this also makes a difference. In the studies we are basing on \( I_{\text{H}}/I_{\text{Fe}} \) ratios, however, in the final discussion we use normalization procedure considering bulk hydrogen concentration value as an internal standard. In other words, we assume that at a 0.75 \( \mu \text{m} \) depth in all analyzed samples hydrogen concentration is equal to 56 ppm. This procedure allows us to get concentration versus depth graphs and not ion current ratio versus depth.

In the second series of the studies with samples AR, MEP200, and MIX, more interesting results were obtained (Figs. 8–11). Registered currents of the secondary positive ions of both \( \text{H}^+ \), and \( \text{H}_2^+ \) are even lower for MIX sample than those noted for MEP200 (Figs. 9, and 10), with some bigger ones observed for AR sample. However, a very interesting change in hydrogen contents may be observed from Fig. 10. Hence, the currents of hydrogen monoatomic ions are slightly lower for MIX sample in comparison with those of MEP200, the current of molecular ions containing hydrogen are the lowest for MEP200 sample in comparison with two others (AR, MIX). Moreover, the big discrepancy in the current ratios in the samples after electropolishing operations (MEP200, MIX) may indicate a probable dynamic behavior in the hydrogen monoatomic ions tending to form \( \text{H}_2 \) molecules.

Much more information may be obtained from the comparison of hydrogen concentration analyses coming from all studied samples (Fig. 11). For this purpose, the bulk hydrogen concentration of 56 at. ppm [45] was assumed to be reached after sputtering of about 750 nm in-depth. The highest hydrogen concentrations, very slightly differing between those in AR and MP samples, could be expected. The second comparable two courses of hydrogen concentrations are related to EP and MEP50 samples, with that of EP sample running slightly lower. The best results concerning hydrogen concentrations are related to MIX and MEP200 samples with the magnetoelectropolished one revealing a very steep fall in hydrogen concentration from the very top of the surface.

Matrix effects in SIMS analysis significantly influence measured secondary ion currents. Oxygen presence strongly influences positive and negative metallic ion emission (Figs. 3, and 5). The oxygen depth profiles (raw data) can be treated as a measure of oxygen distribution in the near surface layers. The results show that most oxidized samples are MP, i.e. mechanically polished, and AR.

Oxygen and hydrogen raw data profiles differ for each polishing procedure (Figs. 3, and 5), showing differences in concentration distributions and also pointing out that concentration of these elements is not strictly related to each other.

Indeed, surface roughness and hydrogen content cannot be treated separately. Developed topography increases condensation and adsorption of hydrogen, water, hydrocarbons, etc. SIMS data give integral values of hydrogen secondary ion currents. Emission of molecular ions containing hydrogen may give some suggestions on hydrogen presence origin.

Our previous studies performed on MP, EP, and MEP sample surfaces indicated decreasing roughness (evaluated both by 2D
standard roughness measurements (Ra, Rz, and Rt), as well as 3D interferometry measurements (Sa, and Sz) [20,46], as presented in our works elsewhere [5,7,11,19,20]. Therefore, the results obtained by SIMS are in agreement with the surface roughness data concerning their mode of treatment.

5. Conclusion

SIMS analysis of hydrogen contents in near-surface layers of AISI 316L SS after electrolysing treatment under different conditions was performed. Based on the experimental results obtained, several conclusions may be formulated.

Obtained SIMS data show the presence of hydrogen in a series of analyzed samples. Hydrogen concentration profiles were possible to determine using positive secondary ion currents of H+, Cr+, Fe+ and Ni+, under assumption of constant (bulk) concentration present in analyzed samples. Hydrogen concentration profiles were possible to determine using positive secondary ion currents of H+, Cr+, Fe+ and Ni+, under assumption of constant (bulk) concentration present in each of the samples at the erosion depth of 600 nm. Conclusions of the possible origin of hydrogen presence can only be estimated, basing on positive and negative molecular hydrogen secondary ion currents.

The SIMS studies revealed a considerable differentiation in the hydrogen concentrations depending on the kind of sample surface treatment. Stainless steel samples both AR and MP have shown very similar contents of hydrogen. The samples after electrolytic polishing, EP and MEP50, have revealed a diminished content of hydrogen, in comparison with both AR and MP ones. The increased current density (MEP200) and electrolyte stirring (MIX) during electropolishing resulted in further lowering of the hydrogen content in samples, with the best results regarding hydrogen content decrease obtained on MEP200 sample.

A final general conclusion may be formulated as follows: electropolishing parameters and conditions affect the hydrogen contents in near-surface layers of the treated stainless steel. In the process of magnetoelectropolishing, characteristic with the self-contained electrolyte whirling, the least contents of hydrogen have been obtained.

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