уменьшается на 3,4 масс.%, и скорость десорбции снижается.

Из полученных графиков можно сделать вывод, что максимальная концентрация сорбированного водорода достигается при давлении 8 атм. Скорость десорбции зависит от температуры, при которой протекает процесс, и наиболее низкая скорость десорбции получена при температуре 30 ^{o}C [5].

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FORMATION OF NiO/YSZ ANODE LAYER ON THE SURFACE OF SOLID OXIDE FUEL CELL CARRIER METAL BASE

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ФОРМИРОВАНИЕ NiO/YSz АНОДНОГО СЛОЯ НА ПОВЕРХНОСТИ НЕСУЩЕЙ МЕТАЛЛИЧЕСКОЙ ОСНОВЫ ТВЕРДООКСИДНОГО ТОПЛИВНОГО ЭЛЕМЕНТА

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В представленной работе анодный слой твердооксидного топливного элемента (ТОТЭ) был сформирован из NiO/YSZ кермета, который представляет собой композит на основе Ni и YSZ (оксид циркония, стабилизированный 8 мол.% оксидом иттрия). Данный слой был сформирован на поверхности несущей Ni-Al основы ТОТЭ методом спекания Ni/YSZ пасты (NiO(50%)/ZrO_2:Y_2O_3(50%) производства

ESL Electroscience, США). Основными изменяемыми параметрами спекания были температура и атмосфера в камере. Поверхность и структура полученных образцов были исследованы посредствам сканирующего электронного микроскопа. Результаты исследования представлены в данной статье.

Solid oxide fuel cells (SOFCs) are electrochemical generators that can directly convert the chemical energy of a fuel gas into electrical energy with high efficiency (~ 80%, with released heat) and in an environment-friendly way [1]. The SOFC consists of three main parts: anode, electrolyte and cathode. The given work is devoted to the formation of the anode layer.

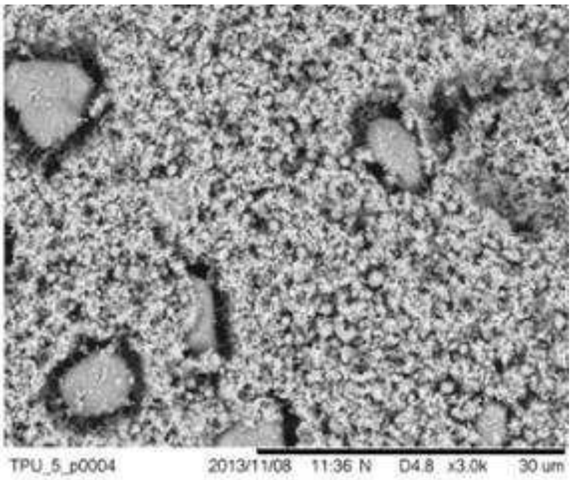
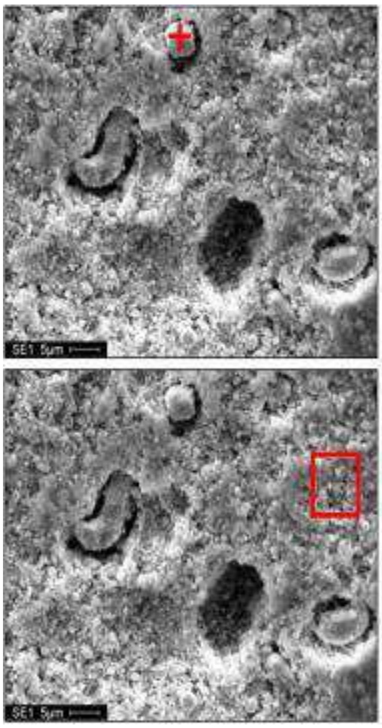


Fig. 1. Ni / YSZ anode layer surface, co-fired in vacuum (1.3 10^{-3} Pa) at T = 1200 ^{0}C

The SOFC anode has four main functions: transport oxygen anions, transport the fuel to the reaction site and products from the reaction site, to catalyze the electrochemical oxidation of the fuel, and transport the product electrons from the reaction site to the current collector at the electrode surface [2]. The chosen NiO/YSZ cermet (mixture of ceramic and metal) allows achieving mentioned properties with one exception; the second function can be achieved by selection of a formation methods. The microstructure of anode layer is determined by the fabrication method.

Nowadays there are two main types of anode layer formation: forming of layer at normal temperature followed by high temperature sintering (screen printing, slip casting, sol-gel method) [3]; forming of layer at high temperatures, such as chemical vapor deposition (CVD), electrochemical vapor deposition (EVD), plasma spraying [4].



Element	Wt%	At%
OK	00.00	00.00
ZrL	00.00	00.00
NiK	100.00	100.00
Matrix	Correction	ZAF

Element	Wt%	At%
OK	20.98	57.84
ZrL	64.24	31.06
NiK	14.78	11.10
Matrix	Correction	ZAF

Fig. 2. Analysis of the samples chemical composition

In this work the method that belongs to the first type was used. Formation of anode layer was carried out by sintering of NiO(50%)/ZrO_2:Y_2O_3(50%) paste (production ESL Electroscience, USA). Thin anode layer was formed by screen printing method on the surface of Ni-Al substrate (Ni_3Al (90 %) + NiAl (10 %)). Such composition of substrates was chosen because during the sintering on the surface of the NiO/YSZ paste under vacuum at temperatures up to 1250 °C shrinkage substrates do not occur. Thin layer of paste was deposed on the surface of Ni-Al substrate, and then it was co-fired in the vacuum atmosphere (1.3 10^{-3} Pa) at the temperature 1200 °C for 2 hours. After that the samples were examined by scanning electron microscope Hitachi TM-3000 (Fig.1).

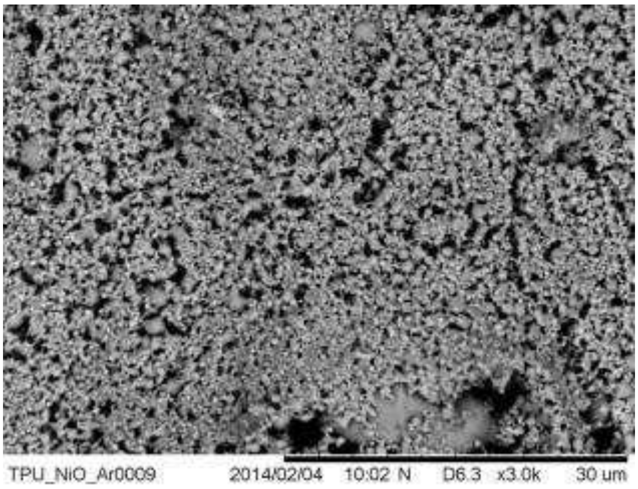


Fig. 3. Ni / YSZ anode layer surface, co-fired in vacuum (1.3 Pa) at T = 1190 °C

It can be seen that agglomerates of the Ni (1–5 µm) were formed during the sintering. This was proved by the analysis of the samples chemical composition (Fig. 2). The one explanation of the Ni agglomerates formation can be the increase of average particle size at the high temperature (more than 900 °C) [3]. In this case the changing of atmosphere from vacuum to argon did not lead to microstructure change.

For avoiding above mantioned problem it was decided to sinter the anode layer in vacuum atmosphere with background pressure 1.3 Pa. Temperature of sintering was 1190 °C. Usually, the formation of anode layer is carried out at the air atmosphere for avoiding the agglomeration of Ni, but in this case Ni-Al base is used. The metal base is oxidized in an air atmosphere.

The obtained cover was investigated by scanning electron microscope (Fig.3). It can be seen that the anode surface is homogeneous; the agglomerates of Ni and other defects are absent. There are no cracks on the surface, despite the high rate of heating to 600 º C / hour. The obtained surface is suitable for further formation of an electrolyte layer.

It can be seen that the anode surface is homogeneous; the agglomerates of Ni and other defects are absent. There are no cracks on the surface, despite the high rate of heating to 600 º C / hour. The obtained surface is suitable for further formation of an electrolyte layer.

Conclusion Based on data obtained in the work it can be noted that the proper selection of background pressure, during the anode paste sintering, allows to avoid the agglomeration of Ni particles. Also it allows to obtain the anode surface without defects. In the sintering process the maximum heating temperature is important. In addition the heating rate affects an anode layer formation. The less heating rate, the anode layer structure is homogeneous; the components evaporate at different temperatures consecutively. In the future a few more techniques for forming the anode layer will be complete and SOFC will be produced.

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