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**A METHOD FOR DISTRIBUTION THE DECOUPLING CAPACITANCE
A THE PRESENCE OF NOISE IN SUPPLY NETS**

It is recommended to reduce power consumption in integrated circuits which allows to reduce noise in power networks up to 40% with an increase in the surface area by 10%. Unlike other available methods, in this case, the power network is more reliable. In this case, the EMMC testing scheme was chosen as a comparison scheme, and a comparative analysis was carried out, using other existing methods.

Keywords: power supply noise, noise aware floorplanning, decoupling capacitance, EMMC test chip, universal successive chip.

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**FABRICATION AND INVESTIGATION OF THE (Pr,Ba)CoO₃ THIN
FILMS FOR THE OXYGEN EVOLUTION REACTION**

The epitaxial (Pr,Ba)CoO₃ thin films with different strain on different substrates have been fabricated by PLD for oxygen evolution reaction (OER). We have investigated the relation between the crystal structure as a function of strain and the resulting effect on the electrocatalytic performance for OER. The RHEED-controlled PLD growth, AFM, XRD, RMS investigation of the thin films, and the analysis of electrochemical properties in electrochemical cells is carried out.

Keywords: oxygen evolution reaction, pulsed laser deposition, (Pr,Ba)CoO₃ epitaxial thin films.

Introduction. To meet the needs of increasing energy consumption, new energy sources and storages are continuously developing. An efficient and clean energy storage is hydrogen, which can be produced via electrochemical water splitting [1]. Electrochemical water splitting driven by a renewable but discontinuous energy source, such as wind or solar, provides a way to store this energy. The water splitting reaction consists of two half reactions, the hydrogen evolution reaction and the oxygen evolution reaction (OER, see Fig.1). The overall efficiency of the process is limited by the OER, which exhibits low rate constants and induces irreversible structural changes in electrode materials, leading to a drop in the performance [2]. To improve performance of such electrochemical cells, tremendous research is being conducted all over the world. One particular focus are

fundamental and applied studies on the electrode/water interactions for different electrode materials, such as metals, metal oxides and others [3].

In recent years, a huge amount of research has been carried out in area of oxide-based electrocatalysts, especially perovskites, spinels and rutiles. These materials show high activity and stability, but still there is a lack of fundamental understanding of dependencies of catalytic performance on the composition and structure of oxide materials.

Perovskite and double perovskite materials have been reported as a good electrodes for OER [4-9]. The focus of most studies was set on finding new materials, ensuring low overpotentials and high stability, as well as on exploring active sites and reaction mechanisms on the atomic scale. The chemical structure of the perovskite and the related non-stoichiometry significantly affects the catalysts' properties. The structure and properties of some perovskites have been extensively studied. However, data is scarce, especially for double perovskites and composite materials. It is known that a variation of the A–B ratio in the ABO_3 perovskite structure, as well as the oxygen deficiency induce point defects in the crystal lattice. In double perovskites, cation ordering supports the oxygen vacancy formation and enhances the mobility of oxygen in the lattice [5]. Besides structural effects related to the point defects and/or cation ordering, the effects of the electronic structure merely related to the energetic position of the oxygen 2p-band center are being discussed [4] as the main reason for a good catalytic performance.

From the abovementioned it is clear that it is necessary to investigate at a new electrode materials, in particular perovskite materials which are promising candidates. The Investigation of these materials and the development of fabrication technologies for electrochemical water splitting cells are demanded. In order to elucidate the details of the actual chemical descriptors, determining the electrocatalytic performance, it is particularly required to investigate well-defined model systems, such as epitaxial thin films, that provide a defined surface topography and area, as well as defined physical properties, such as electrical conductivity, crystal structure and crystal orientation. By this approach, systematic studies can be carried out in order to identify the essential material properties responsible for good or bad catalytic performance.

Experimental part. The investigation of $Pr_{0.5}Ba_{0.5}CoO_3$ (PBCO) thin film electrodes with different strain prepared by pulsed laser deposition (PLD) has been carried out.

The general motivation for this PLD-approach is that PLD allows to grow thin films with defined surface structure as well as defined crystal orientation and

chemical composition. The strain variation was implemented by using different substrates such as: single crystalline LaAlO_3 , NdGaO_3 , SrTiO_3 and DyScO_3 . Thereby, we were aimed to deduce the impact of strain and substrates on the performance and stability of PBCO thin films during the water splitting operation.

In the framework of this research, the PLD growth process for PBCO films on different substrates were developed and optimized. The main parameters of the PLD technology (the oxygen content and pressure of gas in the chamber, the temperature of the substrate, laser fluence) were varied and optimized.

The deposited films were explored by X-ray diffraction (XRD), atomic force microscopy (AFM) and scanning electron microscopy (SEM) for clarifying the phase formation, surface morphology and structure features. These results were a feedback for determining the technological parameters. The influence of substrates was investigated. The strain was investigated by means of X-ray diffraction methods, such as reciprocal space mapping (RMS).

After fabricating thin films, their electrical properties were explored. For this, the epitaxial thin films were contacted by ultrasonic Al-wire bonding. Subsequently, the thin films were electrically characterized in a dedicated van-der-Pauw experimental setup (Lakeshore 8000 series). In this study, we aim to disclose the relation between the crystal structure and electrical conductivity, which is also essential for the electrocatalytic process (as it requires electron transfer at the surface of the active layer).

For the research of electrochemical properties, an electrochemical cell was used. Cyclic voltammetry (CV), as well as impedance spectroscopy were used to study the electrochemical properties in alkaline media (0,1 mol KOH electrolyte). The overpotential was measured in reference to a Hg/HgO reference electrode and Pt was used as counter electrode for hydrogen evolution reaction.

Results and discussion. The Data of structural characterizations, electrical and electrochemical measurements have been collected. In particular, the electrical measurement results are presented in the Table and the electrochemical measurements in Figure.

Properties of PBCO films on different substrates

Substrates	Lattice constant, Å	Film Strain, %	Roughness, nm	Sheet Resistance, Ω/\square
SrTiO ₃	3.905	0.38	1	232
NdGaO ₃	3.86	-0.77	2	231
LaAlO ₃	3.788	-2.62	1.65	378
DyScO ₃	3.94	1.28	3.1	4330 k

We found out that the higher the strain the higher is the sheet resistance of epitaxial films. The very high sheet resistance of the films on the DyScO₃ substrate is due to the island structure of the films. At the same time the highest current density in electrochemical measurements were obtained for the films on the DyScO₃ substrate.

The combined analysis of these data allow us to determine that the impact of the strain and substrates on the performance of PBCO for electrocatalytic performance is essential.

Long term recording and analysis are needed for determining the stability of PBCO thin film properties. This analysis of the experimental results will help to understand the fundamental properties of PBCO as an electrode material for OER.

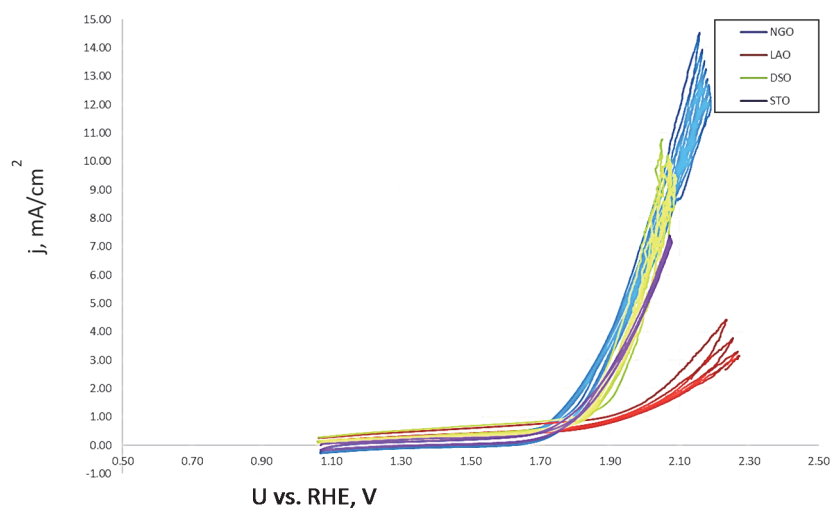


Fig. IR corrected CV for PBCO on different substrates

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**ԹԹՎԱԾՆԻ ՎԵՐԱԿԱՆԳՆՄԱՆ ՌԵԱԿՑԻԱՅԻ ՀԱՄԱՐ (Pr,Ba)CoO₃
ԷՊԻՏԱՔՍԻԱԼ ԹԱՂԱՆԹՆԵՐԻ ՍՏԱՑՈՒՄԸ ԵՎ ՀԵՏԱԶՈՏՈՒՄԸ**

Իմպուլսային լազերային փոշենստեցմամբ (ԻԼՓ) պատրաստվել են (Pr, Ba)CoO₃ տարբեր լարվածությամբ էպիտաքսիալ նուրբ թաղանթներ տարբեր հարթակների վրա՝ թթվածնի վերականգնման ռեակցիայի համար (OER): Ուսումնասիրվել են բյուրեղային կառուցվածքի՝ լարվածությունից ունեցած կախվածությունը և դրա արդյունքում՝ էլեկտրակատալիտիկ հատկությունների և OER-ի կայունության կապը: Իրականացվել է թաղանթների RHEED-ի վերահսկվող իմպուլսային լազերային փոշենստեցում, հետազոտություն՝ AFM, XRD, RMS մեթոդներով, էլեկտրաքիմիական բջիջներում էլեկտրաքիմիական հատկությունների վերլուծություն:

Առանցքային բաներ. թթվածնի վերականգնման ռեակցիա, իմպուլսային լազերային փոշենստեցում, (Pr,Ba)CoO₃ էպիտաքսիալ նուրբ թաղանթներ:

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ПОЛУЧЕНИЕ И ИССЛЕДОВАНИЕ ТОНКИХ ЭПИТАКСИАЛЬНЫХ ПЛЕНОК (Pr,Ba)CoO₃ ДЛЯ РЕАКЦИИ ВОССТАНОВЛЕНИЯ КИСЛОРОДА

Изготовлены эпитаксиальные (Pr,Ba)CoO₃ тонкие пленки с различной деформацией на разных подложках импульсным лазерным осаждением для реакции восстановления кислорода (OER). Исследовано влияние кристаллической структуры и деформации на электрокаталитические характеристики и химическую стабильность для OER. Осуществлены RHEED-контролируемое импульсное лазерное осаждение, AFM, XRD, RMS исследование тонких пленок и анализ электрохимических свойств в выделенных электрохимических ячейках.

Ключевые слова: реакция восстановления кислорода, импульсное лазерное осаждение, (Pr,Ba)CoO₃ эпитаксиальные тонкие пленки.