Oxygen permeability of the MIEC oxides microtubular membranes produced with additive methods

Kovalev I.V.[1,2], **Sivcev V.P.[1]**, **Popov M.P.[1]**, **Nemudry A.P.[1]**

[1]Institute of Solid State Chemistry and Mechanochemistry SB RAS, 18 Kutateladze, Novosibirsk, 630128, Russia,

e-mail: kovalev.ivan.vyacheslavovich@gmail.com

[2]Novosibirsk State Technical University, 20 Prospekt K. Marksa, Novosibirsk, 630073, Russia

Introduction

Complex oxides with mixed ionic-electronic conductivity (MIEC oxides) attract attention by the possibility of their application in the chemical, gas and energy industries. They can be used in different technologies, for example, producing pure oxygen, methane conversion, electrochemistry processes. Membranes based on MIEC oxides allow separating oxygen from the air with 100% selectivity. The integration of such membranes into catalytic reactors will allow combining the stages of oxygen separation and partial oxidation of hydrocarbons.

The aim of this work is studying of oxygen permeability of a porous MIEC oxides microtubular membrane with a controlled microstructure using 3D printing, phase inversion and dip-coating methods for their production.

Setup for studying the high-temperature oxygen permeability of MIEC membranes:
1—AC source; 2— infrared pyrometer; 3—gas mixer; 4—reactor; 5—QMS.

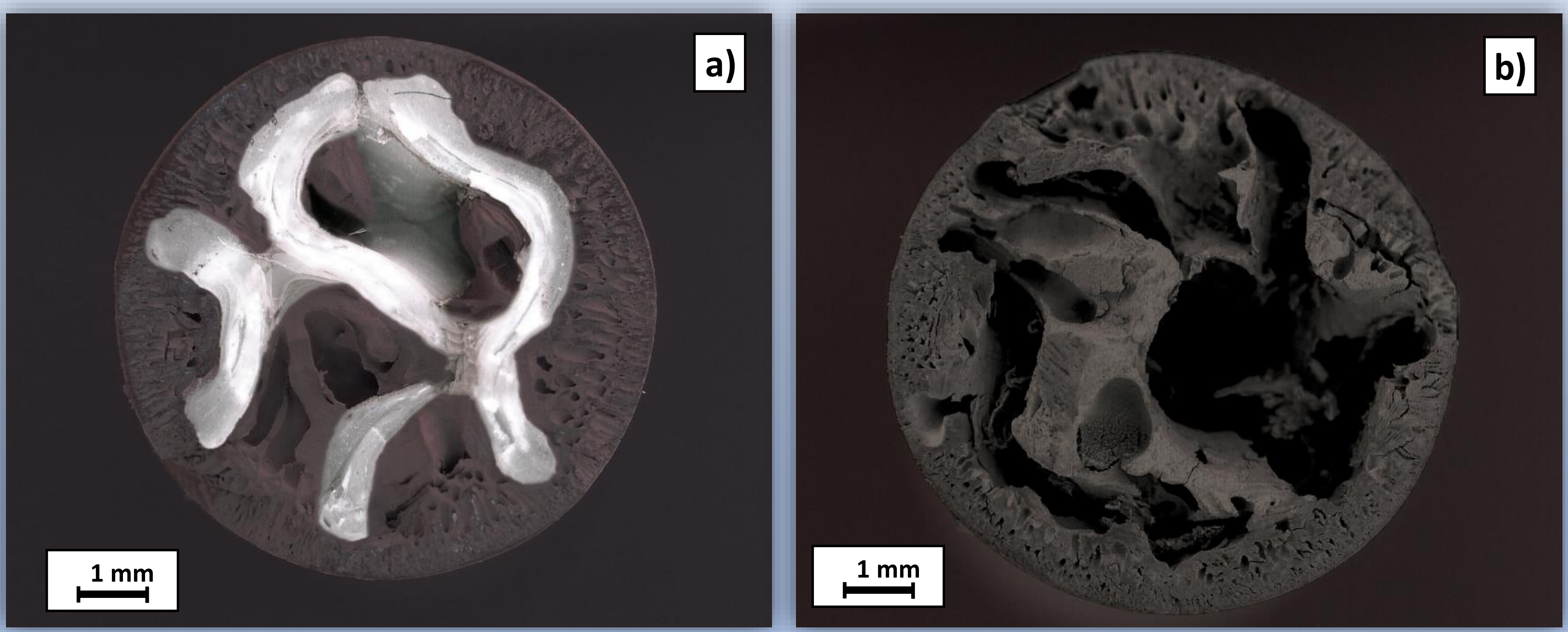
Oxygen permeability of the MIEC oxides microtubular membranes produced with additive methods

Kovalev I.V.[1,2], **Sivcev V.P.[1]**, **Popov M.P.[1]**, **Nemudry A.P.[1]**

[1]Institute of Solid State Chemistry and Mechanochemistry SB RAS, 18 Kutateladze, Novosibirsk, 630128, Russia,

e-mail: kovalev.ivan.vyacheslavovich@gmail.com

[2]Novosibirsk State Technical University, 20 Prospekt K. Marksa, Novosibirsk, 630073, Russia



Microstructure of oxygen permeable membranes made using additive methods: a) before pre-sintering; b) after pre-sintering

Methods

It is necessary to develop technologies for obtaining gas-tight membranes based on MIEC oxides for successful application in catalytic reactors. The most promising way is the production of membranes in the form of microtubes, that can significantly increase the oxygen permeability.

Porous MIEC oxides microtubular membrane with a controlled microstructure were prepared using 3D printing, phase inversion and dip-coating methods.

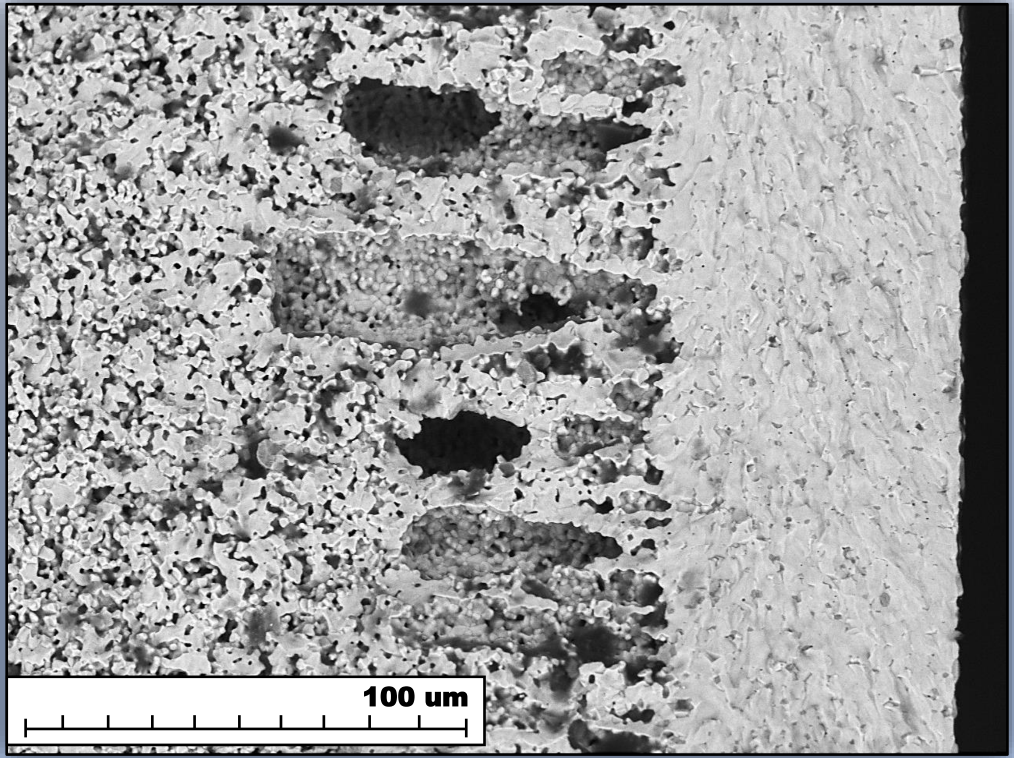
Oxygen permeability of the MIEC oxides microtubular membranes produced with additive methods

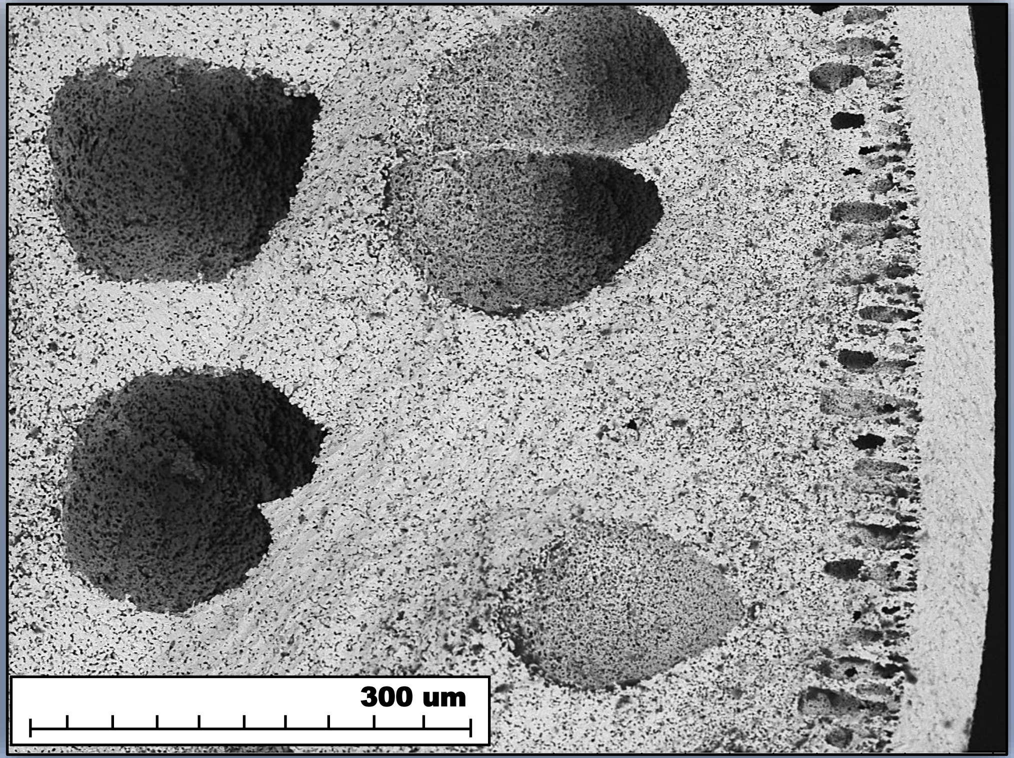
Kovalev I.V.[1,2], **Sivcev V.P.[1]**, **Popov M.P.[1]**, **Nemudry A.P.[1]**

[1]Institute of Solid State Chemistry and Mechanochemistry SB RAS, 18 Kutateladze, Novosibirsk, 630128, Russia,

e-mail: kovalev.ivan.vyacheslavovich@gmail.com

[2]Novosibirsk State Technical University, 20 Prospekt K. Marksa, Novosibirsk, 630073, Russia





Microstructure of oxygen permeable membranes made using dip-coating

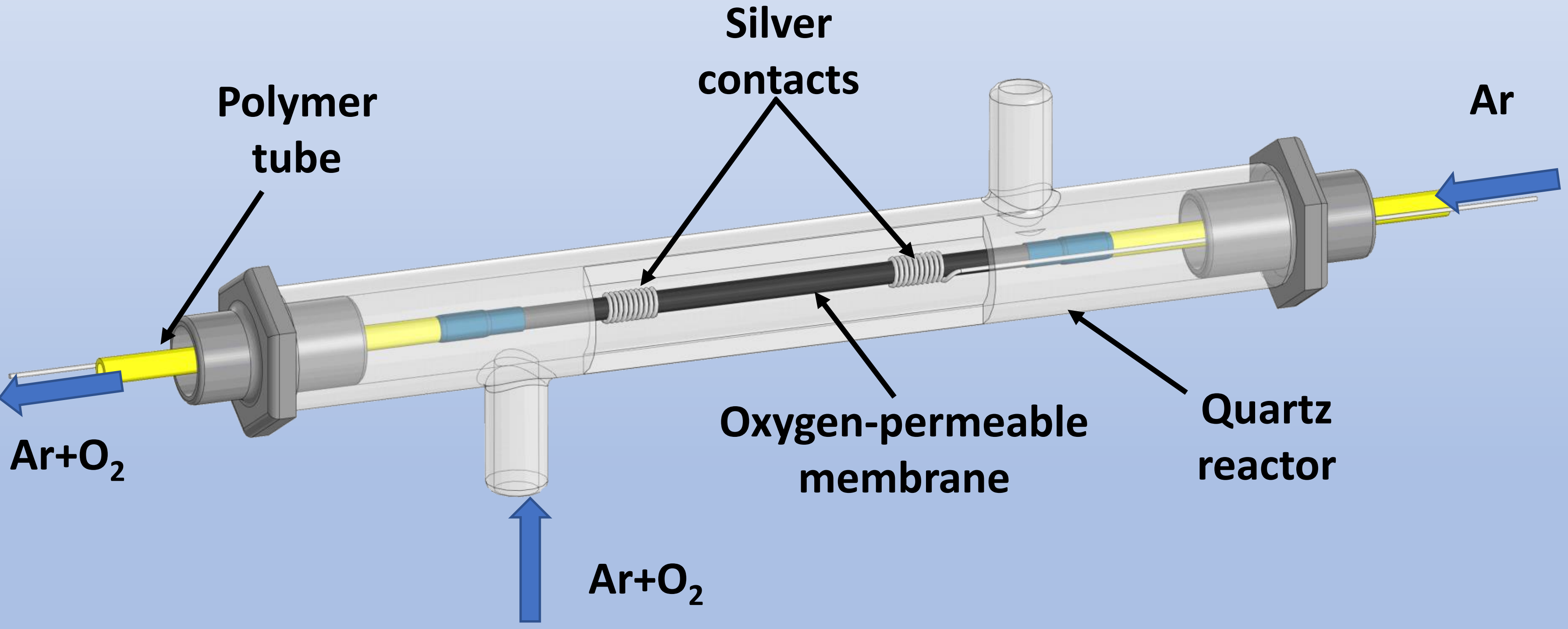
Oxygen permeability of the MIEC oxides microtubular membranes produced with additive methods

Kovalev I.V.[1,2], Sivcev V.P.[1], Popov M.P.[1], Nemudry A.P.[1]

[1]Institute of Solid State Chemistry and Mechanochemistry SB RAS, 18 Kutateladze, Novosibirsk, 630128, Russia,

e-mail: kovalev.ivan.vyacheslavovich@gmail.com

[2]Novosibirsk State Technical University, 20 Prospekt K. Marksa, Novosibirsk, 630073, Russia



Reactor for studying the high-temperature oxygen permeability of MIEC membranes

Methods

For the measurements, the membranes were hermetically sealed on both sides by polymer pipe sockets. At a certain distance from membrane's edges, we deposited a conducting coating and fixed silver-wire contacts. After this, the membrane was placed into a hermetically sealed quartz reactor.

The reactor was installed vertically, the flowing gas was supplied through the lower socket for smoothing out the temperature gradient over the reactor length. The heating was realized by passing alternating current through the membrane from a current source.

Oxygen permeability of the MIEC oxides microtubular membranes produced with additive methods

Kovalev I.V.[1,2], **Sivcev V.P.**[1], **Popov M.P.**[1], **Nemudry A.P.**[1]

[1]*Institute of Solid State Chemistry and Mechanochemistry SB RAS, 18 Kutateladze, Novosibirsk, 630128, Russia,*

e-mail: kovalev.ivan.vyacheslavovich@gmail.com

[2]*Novosibirsk State Technical University, 20 Prospekt K. Marksa, Novosibirsk, 630073, Russia*

Conclusion

It was shown that the use of additive methods such as 3D printing, phase inversion and dip-coating is the most promising way of the microtubular membranes production that can significantly increase the oxygen permeability.

Acknowledgments

The research was funded by RFBR and Novosibirsk region, project number 20-43-543025.

References

[1] *A. Leo, S. Liu, J. C. D. da Costa J. Membr. Sci.* ***2009****, 340, 148-153*

[2] *C. Buysse et al. J. Membr. Sci.* ***2010****, 359, 86-92*

[3] *A. Kovalevsky et al. J. Membr. Sci.* ***2011****, 368, 223-232*