Radiation Thermal Sintering of Oxide and Composite Materials for Hydrogen Energy

Sadykov V.A.[1], Sadovskaya E.M.[1], Bespalko Yu.N.[1], Eremeev N.F.[1], Mikhailenko M.A.[2], Bryazgin A.A.[3], Korobeynikov M.V.[3]

1 – Boreskov Institute of Catalysis, Novosibirsk, Russia

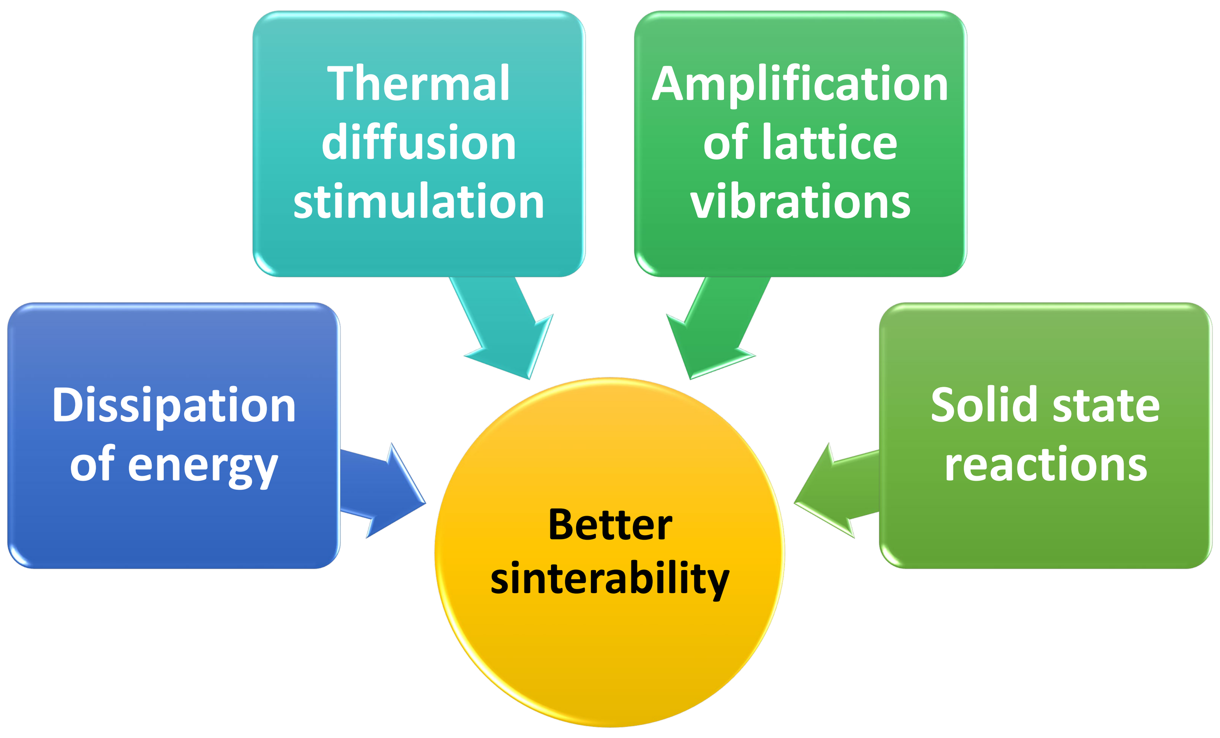
2 – Institute of Solid State Chemistry and Mechanochemistry, Novosibirsk, Russia

3 – Budker Institute of Nuclear Physics, Novosibirsk, Russia

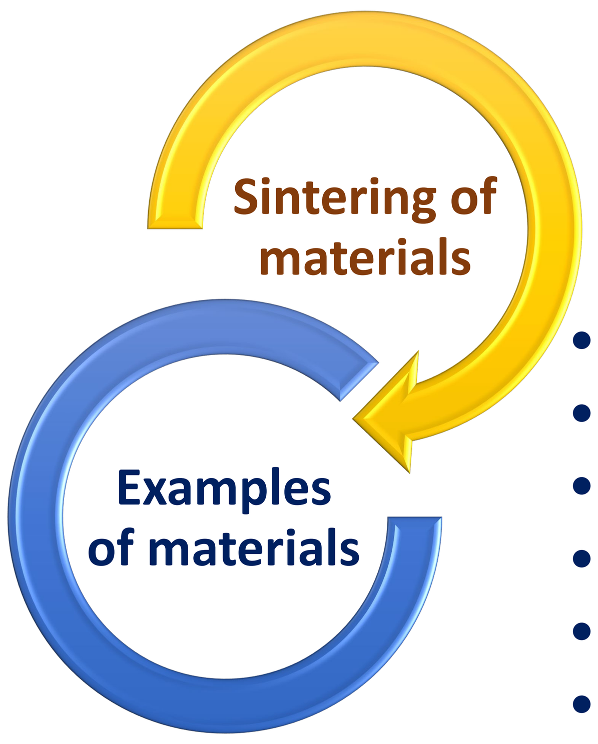
E-mail: sadykov@catalysis.ru

Modern technologies of material processing for obtaining functional materials with unique characteristics are being intensively developed. Advanced sintering techniques such as microwave sintering, laser sintering, hot pressing, etc. are utilized for obtaining durable gas-tight functional ceramics for energy applications, since conventional sintering in a furnace does not always allow to achieve required tightness.

The main features



RTS application



- SOFC electrodes
- Electrolytes
- Permselective membranes
- Catalysts
- Others

- Perovskites
- Fluorites
- Pyrochlores
- Metals
- Composites
- Others

Radiation thermal sintering (RTS) by electron beams is based on bombardment of ceramic samples and functional layers by high-energy electron beams.

RTS was carried out using an ILU 6 accelerator. Electrons' impulses with 2.4 MeV energy, 328 mA pulse beam current, pulse duration ~ 600 µs, narrow scan, up to 25 Hz pulses frequency were used. Samples' temperature was controlled using Pt-Pt-Rh thermocouple (S-type) and FildPoint controlling module. Processing temperature parameters were set using controlling software of accelerator. Power adjustment was carried out by changing pulses frequency. The heating rate was 50 °C min^{-1}, and after achieving required temperature in the range of 1100 – 1300 °C samples were sintered for 30 min at a given temperature.

The efficiency of the RTS was demonstrated for Ni-Zn and Mn-Zn ferrites synthesis via achieving the maximal transformation of the initial oxide mixtures into the ferrites [1]. Perovskites (such as Pr nickelates-cobaltites) and perovskite – fluorite nanocomposites after RTS maintain their transport properties such as a high oxygen mobility (Fig. 1) [2]. Advances were achieved in radiation thermal sintering of hydrogen separation materials such as Ln tungstates/molybdates and their nanocomposites with NiCu (Fig. 2), however, further optimization of sintering conditions is required [3]. RTS was demonstrated to be efficient technique for obtaining functional layers of solid oxide fuel cells and permselective membranes with required performance [2,3].

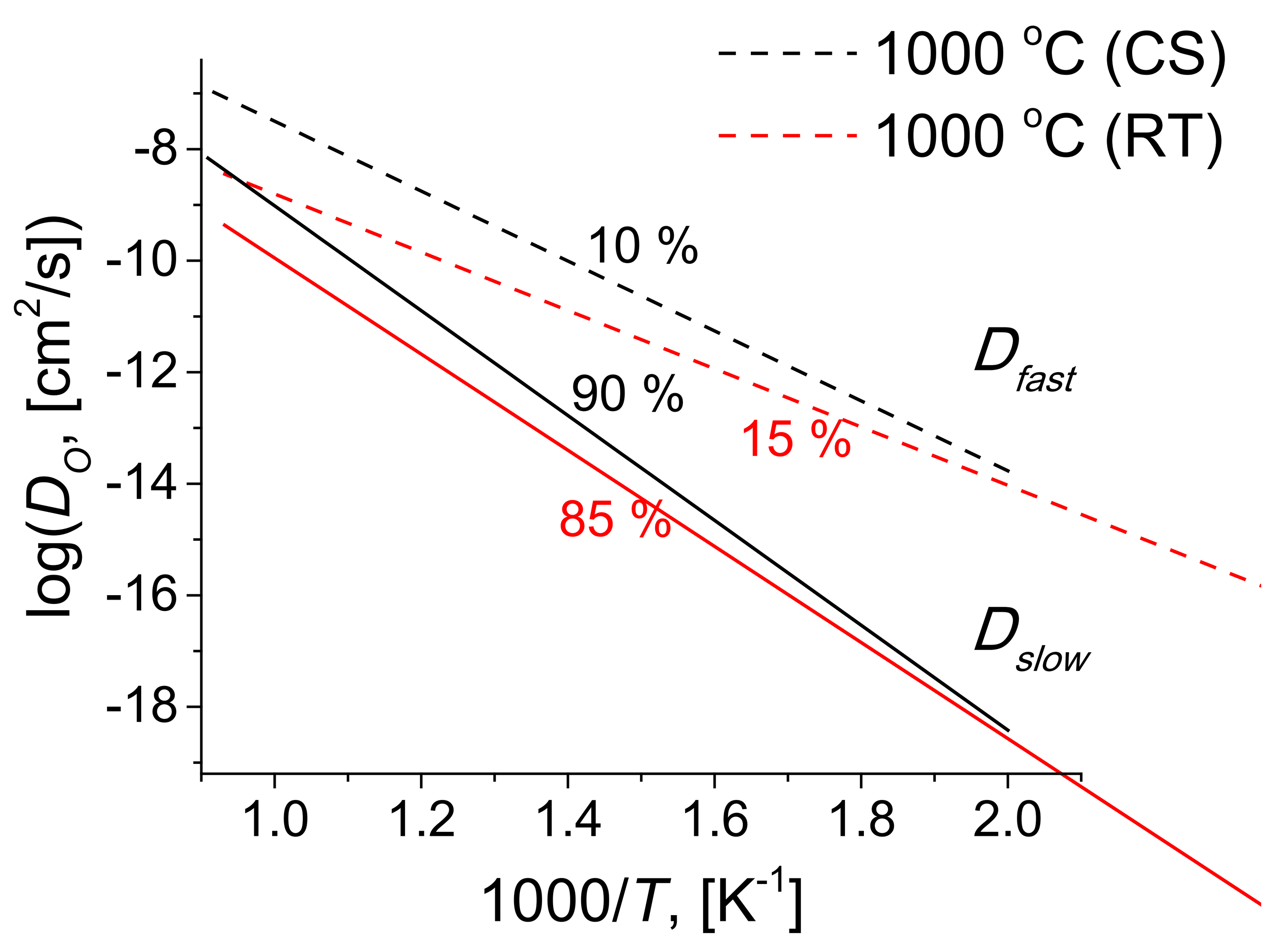


Fig. 1. Arrhenius plots for oxygen tracer diffusion coefficient for $PrNi_{0.5}Co_{0.5}O_3$ sintered by conventional (CS) and radiation-thermal (RT) sintering at 1000 °C [2].

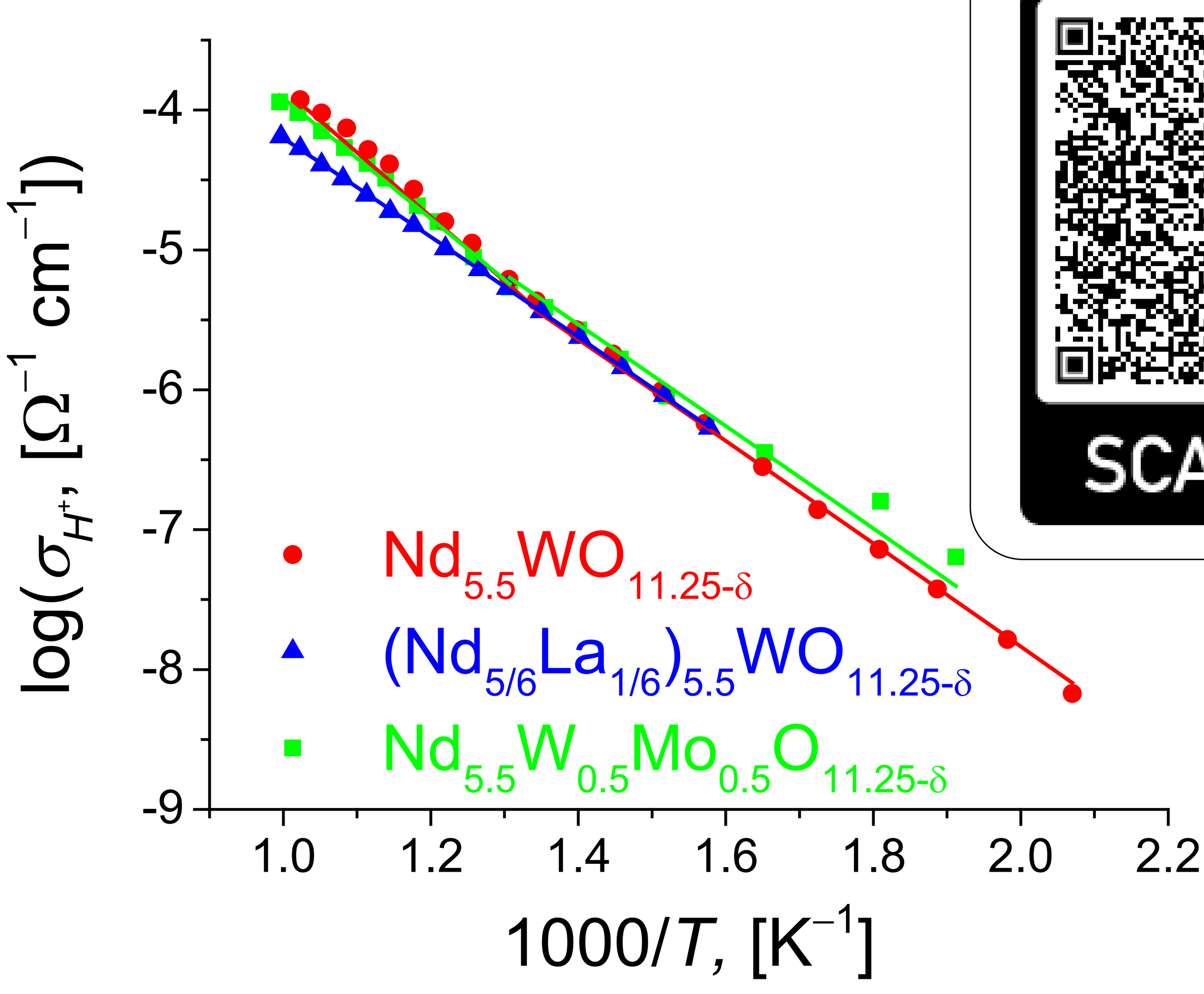


Fig. 2. Protonic conductivity of Nd tungstates sintered using electron beams at 1100 °C [3]

Acknowledgement:

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References

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