SUPPLEMENTARY

to

Chemical lattice strain in nonstoichiometric oxides: an overview

Dmitry S. Tsvetkov[*1], *Vladimir V. Sereda*[1,2], *Dmitry A. Malyshkin*[1,2], *Ivan L. Ivanov*[1,2], *Andrey Yu. Zuev*[1]

[1]Institute of Natural Sciences and Mathematics, Ural Federal University,
620002, 19 Mira St., Yekaterinburg, Russia
[2]Laboratory of Hydrogen Energy, Ural Federal University,
620002, 19 Mira St., Ekaterinburg, Russia
*corresponding author: dmitry.tsvetkov@urfu.ru

Table S1. Chemical expansion coefficients for some fluorite-type oxides $Ce_{1-x}R_xO_{2-\delta}$ (R=Pr, Gd, Y, Sm, Zr)

Oxide	Temperatures, °C	δ range	$\beta = \varepsilon_{chem}/\Delta\delta$	Source
$CeO_{2-\delta}$	900	0.02-0.20	0.092	1
		0.02-0.10	0.101	2
		0.12-0.18	0.073	
$Ce_{0.9}Pr_{0.1}O_{2-\delta}$	650-900	0.01-0.06	0.087	3
$Ce_{0.8}Pr_{0.2}O_{2-\delta}$	800	0.05-0.10	0.084	4
		0.10-0.15	0.108	
$Ce_{0.9}Gd_{0.1}O_{2-\delta}$	700-900	0.00-0.14	0.101	5
	700-900	0.01-0.07	0.132	6
	800-900	0.08-0.14	0.078	6
$Ce_{0.8}Gd_{0.2}O_{2-\delta}$	700-800	0.10-0.15	0.055	7, 8
$Ce_{0.9}Y_{0.1}O_{2-\delta}$	700-1000	0.05-0.23	0.086	9
$Ce_{0.8}Y_{0.2}O_{2-\delta}$	700-1000	0.10-0.25	0.075	9
$Ce_{0.8}Y_{0.2}O_{2-\delta}$	900	0.12-0.20	0.080	10
$Ce_{0.9}Sm_{0.1}O_{2-\delta}$	700-1000	0.05-0.18	0.088	9
$Ce_{0.8}Sm_{0.2}O_{2-\delta}$	700-1000	0.10-0.20	0.092	9
$Ce_{0.5}Zr_{0.4}Pr_{0.1}O_{2-\delta}$	700-900	0.00-0.12	0.046	5
$Ce_{0.5}Zr_{0.5}O_{2-\delta}$	-	0.00-0.25	0.048	5
$Ce_{0.8}Zr_{0.2}O_{2-\delta}$	700	0.06-0.15	0.055	11
	800	0.05-0.15	0.044	
	900	0.05-0.15	0.062	

Table S2. Chemical expansion coefficients for some $La_{1-x}M_xCr_{1-y}B_yO_{3-\delta}$ substituted chromites at 1000 °C

Oxide	$\Delta\delta$	$\beta = \varepsilon_{chem}/\Delta\delta$	Source
$La_{0.8}Sr_{0.2}CrO_{3-\delta}$	0.10	0.016	12
$La_{0.76}Sr_{0.24}CrO_{3-\delta}$	0.12	0.020	12
$La_{0.7}Sr_{0.3}CrO_{3-\delta}$	0.15	0.023	12
$La_{0.9}Ca_{0.1}CrO_{3-\delta}$	0.09	0.021	13
$La_{0.8}Ca_{0.2}CrO_{3-\delta}$	0.04	0.028	13
$La_{0.7}Ca_{0.3}CrO_{3-\delta}$	0.10	0.036	12
$La_{0.8}Sr_{0.2}Cr_{0.97}V_{0.03}O_{3-\delta}$	0.07	0.027	13
$La_{0.7}Ca_{0.3}Cr_{0.9}Al_{0.1}O_{3-\delta}$	0.12	0.034	12
$La_{0.7}Ca_{0.3}Cr_{0.9}Ti_{0.1}O_{3-\delta}$	0.07	0.032	12
$LaCr_{0.95}Mg_{0.05}O_{3-\delta}$	0.02	0.016	14
$LaCr_{0.85}Mg_{0.15}O_{3-\delta}$	0.07	0.010	14

Table S3. Chemical expansion coefficients for some perovskite-like complex oxides containing Fe or Co

Oxide	Temperatures, °C	$\Delta\delta$	$\beta = \varepsilon_{chem}/\Delta\delta$	Source
$Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-\delta}$	room temperature (annealed samples)	0.22	0.012	[15]
	400-600	0.15	0.033	[16]
	700-950	0.17	0.019-0.021	[17]
	600	0.09	0.026	[18]
	700	0.10	0.022	[18]
	800	0.11	0.019	[18]
	900	0.12	0.016	[18]
$SrCo_{0.8}Fe_{0.2}O_{3-\delta}$	700-950	0.19	0.026–0.032	[17]
$SrFe_{0.7}Al_{0.3}O_{3-\delta}$	750-950	0.07	0.046	[19]
$La_{0.8}Sr_{0.2}Fe_{0.7}Ga_{0.3}O_{3-\delta}$	900	0.04	0.039	[20]
$SrSn_{0.65}Fe_{0.35}O_{3-\delta}$	700-1000	0.015	0.032-0.041	[21]
$SrTi_{0.65}Fe_{0.35}O_{3-\delta}$	700-1000	0.06	0.040-0.049	[22]
$La_{0.2}Sr_{0.8}Fe_{0.55}Ti_{0.45}O_{3-\delta}$	789-998	0.05	0.052	[23]
$Nd_{0.7}Sr_{0.3}Fe_{0.7}Co_{0.3}O_{3-\delta}$	750-1000	0.05	0.046	[24]
$Nd_{0.6}Sr_{0.4}Fe_{0.7}Co_{0.3}O_{3-\delta}$	650-1000	0.10	0.041	[24]
$Nd_{0.5}Sr_{0.5}Fe_{0.7}Co_{0.3}O_{3-\delta}$	550-1000	0.13	0.036	[24]
$Nd_{0.3}Sr_{0.7}Fe_{0.7}Co_{0.3}O_{3-\delta}$	550-1000	0.17	0.040	[24]
$Nd_{0.4}Sr_{0.6}FeO_{3-\delta}$	650-1000	0.11	0.040	[25]
$Nd_{0.3}Sr_{0.7}FeO_{3-\delta}$	650-1000	0.12	0.041	[25]
$Nd_{0.2}Sr_{0.8}FeO_{3-\delta}$	650-1000	0.12	0.041	[25]
$Ba_{0.95}La_{0.05}FeO_{3-\delta}$	850-950	0.025	0.061-0.071	[26]
$SrFeO_{3-\delta}$	750-900	0.2	0.0574	[27]
	room temperature (annealed samples)	0.3	0.0197	[27]
$La_{0.3}Sr_{0.7}FeO_{3-\delta}$	800	0.17	0.035	[28]
$La_{0.5}Sr_{0.5}FeO_{3-\delta}$	800	0.10	0.059	[29]
$La_{0.5}Sr_{0.5}FeO_{3-\delta}$	750-900	0.065	0.033	[30]
$La_{0.6}Sr_{0.4}FeO_{3-\delta}$	500-900	0.16	0.020	[31]
	659-777	0.05	0.037	[32]
$La_{0.8}Sr_{0.2}FeO_{3-\delta}$	850-900	0.025	0.015	[33]
$La_{0.6}Sr_{0.4}Fe_{0.8}Co_{0.2}O_{3-\delta}$	600-800	0.13	0.022	[34]
	700-900	0.13	0.031	[35]
	700-890	0.15	0.032	[36]
$La_{0.6}Sr_{0.4}Fe_{0.6}Co_{0.4}O_{3-\delta}$	600-800	0.13	0.030	[34]
$La_{0.6}Sr_{0.4}Fe_{0.5}Co_{0.5}O_{3-\delta}$	500-900	0.17	0.018	[37]
$La_{0.6}Sr_{0.4}Fe_{0.4}Co_{0.6}O_{3-\delta}$	600-800	0.12	0.028	[34]
$La_{0.6}Sr_{0.4}Fe_{0.2}Co_{0.8}O_{3-\delta}$	600-800	0.14	0.024	[34]
	800	0.18	0.022	[38]
$La_{0.5}Sr_{0.5}Fe_{0.5}Co_{0.5}O_{3-\delta}$	800-1000	0.12	0.036-0.039	[39]
$La_{0.1}Sr_{0.9}Fe_{0.2}Co_{0.8}O_{3-\delta}$	900-1000	0.12	0.047	[40]
$La_{0.3}Sr_{0.7}CoO_{3-\delta}$	901	0.13	0.035	[41]
$La_{0.5}Sr_{0.5}CoO_{3-\delta}$	800	0.12	0.035	[39]
$La_{0.6}Sr_{0.4}CoO_{3-\delta}$	500-900	0.17	0.022	[37]
	892	0.11	0.030	[41]
$La_{0.8}Sr_{0.2}CoO_{3-\delta}$	891	0.07	0.025	[41]
$LaCoO_{3-\delta}$	950-1050	0.03	0.020	[42]
$(La_{0.6}Sr_{0.4})_{0.99}CoO_{3-\delta}$	900	0.05	0.027	[43]
$(La_{0.6}Sr_{0.4})_{0.99}Co_{0.9}Ni_{0.1}O_{3-\delta}$	900	0.06	0.028	[43]

$(La_{0.3}Sr_{0.7})_{0.99}Co_{0.9}Ni_{0.1}O_{3-\delta}$	900	0.04	0.033	[43]

Table S4. Chemical expansion coefficients for some double perovskite oxides and Ruddlesden-Popper oxides

Oxide	Temperatures, °C	δ range	$\beta_a = \varepsilon_{chem}(a)/\Delta\delta$	$\beta_c = \varepsilon_{chem}(c)/\Delta\delta$	Source
$LaBaCo_2O_{6-\delta}$	717-853	0.27-0.54	0.037-0.039	0.011-0.017	44
	1000	0.76-0.84	0.026	-0.016	45, 46
$PrBaCo_2O_{6-\delta}$	573-777	0.43-0.80	0.013	-0.005	47
	852	0.73-0.83	0.017	-0.008	
	900	0.55-0.96	0.002	-0.009	48, 49
	200-1000	0.37-0.81	0.006	-0.017	50 *
$NdBaCo_2O_{6-\delta}$	573-777	0.49-0.86	0.010-0.011	-0.008	51
	852	0.71-0.90	0.008	-0.007	
	200-1000	0.44-0.86	0.013	$-7.04\cdot10^{-5}$	50 **
$GdBaCo_2O_{6-\delta}$	350	0.36-0.65	–	-0.005	52
	440	0.59-0.70	0.007	-0.011	53
	600-750	0.60-0.95	0.008	-0.009	54
$PrBaFe_2O_{6-\delta}$	RT	0.50-0.90	0.0094	-0.0323	55
$NdBaFe_2O_{6-\delta}$		0.50-0.95	0.0088	-0.0354	56, 57
$SmBaFe_2O_{6-\delta}$		0.50-0.92	0.0080	-0.0385	57-59
$EuBaFe_2O_{6-\delta}$		0.59-0.85	0.0084	-0.0381	60
$GdBaFe_2O_{6-\delta}$		0.61-0.90	0.0078	-0.0415	61
$PrBaFeMnO_{6-\delta}$	RT	0.00-1.00	0.022	-0.008	62
$PrBaMn_2O_{6-\delta}$	RT	0.00-1.00	0.022	$2.00\cdot10^{-4}$	
	711	0.83-1.00	0.011	0.016	63
$Sr_2FeMoO_{6-\delta}$	RT	0.01-0.09	0.012	-0.016	64
$La_2NiO_{4+\delta}$	800	0.01-0.06	-0.028 ***	0.076 ***	65
$La_2(Ni_{0.9}Cu_{0.1})O_{4+\delta}$	600-900	0.01-0.07	-0.051 ***	0.84 ***	66
$La_2(Ni_{0.9}Co_{0.1})O_{4+\delta}$	600-900	0.09-0.16	-0.051 ***	0.62 ***	66
$La_2(Ni_{0.9}Fe_{0.1})O_{4+\delta}$	600-900	0.10-0.16	-0.081 ***	0.70 ***	66

* orthorhombic symmetry, $\beta_b = \varepsilon_c(b)/\Delta\delta = 0.006$

** orthorhombic symmetry, $\beta_b = \varepsilon_c(b)/\Delta\delta = 0.017$

*** please note that as the oxygen content for Ruddlesden-Popper phases is written as "4+δ" unlike "*x*-δ" for the other oxides, here negative β refers to expansion, and positive – to contraction upon reduction (oxygen loss)

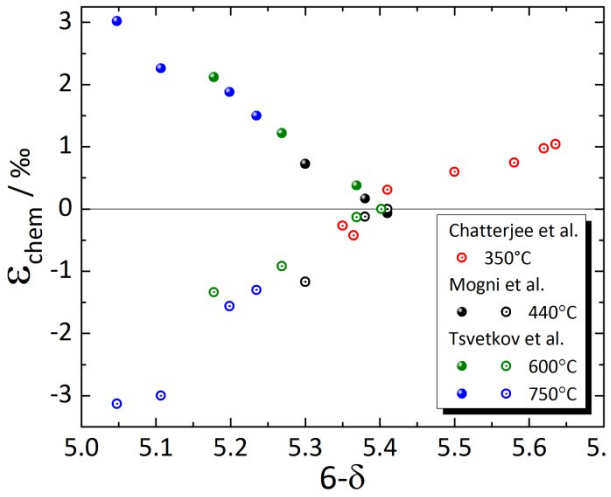

Fig. S1. Chemical strain of $GdBaCo_2O_{6-\delta}$:[52-54] filled symbols – $\varepsilon_{chem}(a)$, empty symbols – $\varepsilon_{chem}(c)$

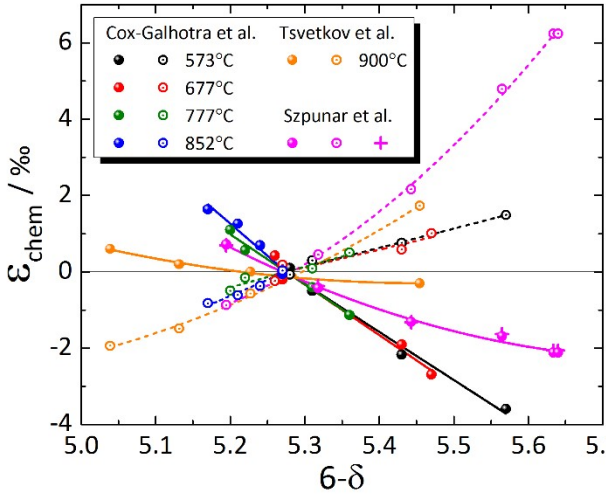

Fig. S2. Chemical strain of $PrBaCo_2O_{6-\delta}$:[47-50] filled symbols – $\varepsilon_{chem}(a)$, empty symbols – $\varepsilon_{chem}(c)$, crosses – $\varepsilon_{chem}(b)$, lines are given to guide the eye only

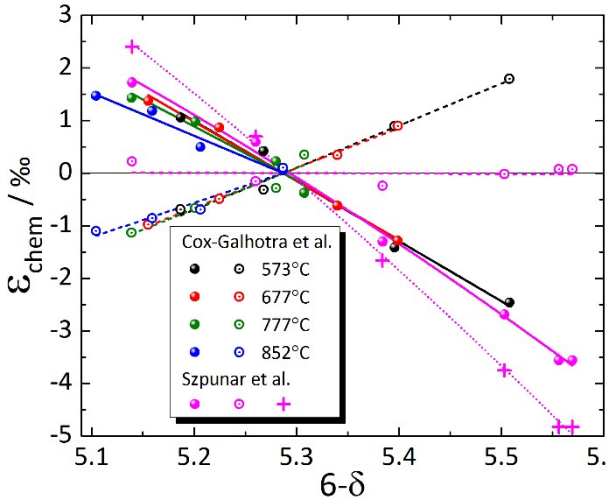

Fig. S3. Chemical strain of $NdBaCo_2O_{6-\delta}$:[50, 51] filled symbols – $\varepsilon_{chem}(a)$, empty symbols – $\varepsilon_{chem}(c)$, crosses – $\varepsilon_{chem}(b)$, lines are given to guide the eye only

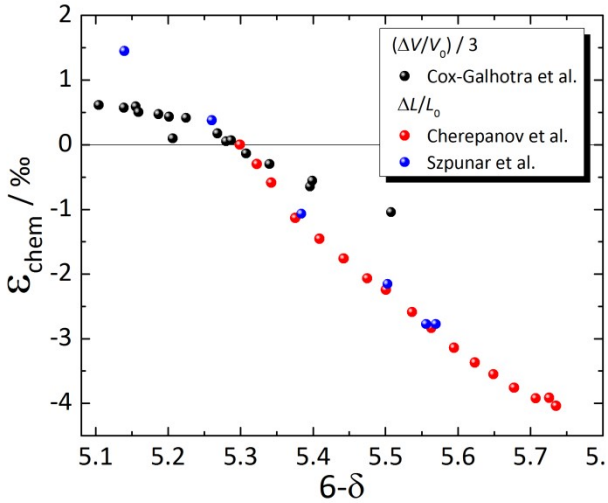

Fig. S4. Volumetric and average linear chemical strain of $NdBaCo_2O_{6-\delta}$[50, 51, 67]

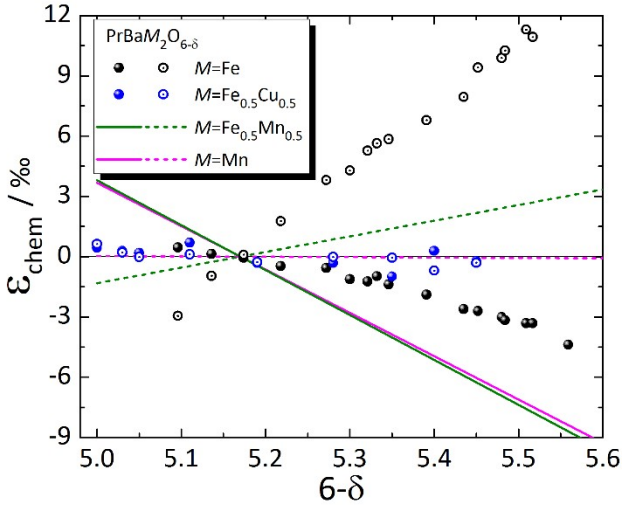

Fig. S5. Chemical strain of PrBa$M_2O_{6-\delta}$ (M = Fe,[55] $Fe_{0.5}Cu_{0.5}$,[68, 69] $Fe_{0.5}Mn_{0.5}$,[62] Mn[62]): filled symbols and solid lines – $\varepsilon_{chem}(a)$,

empty symbols and dashed lines – $\varepsilon_{chem}(c)$

References

1. M. Mogensen, N. M. Sammes and G. A. Tompsett, *Solid State Ionics*, 2000, **129**, 63-94.
2. H.-W. Chiang, R. N. Blumenthal and R. A. Fournelle, *Solid State Ionics*, 1993, **66**, 85-95.
3. S. R. Bishop, H. L. Tuller, Y. Kuru and B. Yildiz, *Journal of the European Ceramic Society*, 2011, **31**, 2351-2356.
4. C. Chatzichristodoulou, P. V. Hendriksen and A. Hagen, *Journal of The Electrochemical Society*, 2010, **157**, B299.
5. S. R. Bishop, D. Marrocchelli, W. Fang, K. Amezawa, K. Yashiro and G. W. Watson, *Energy & Environmental Science*, 2013, **6**, 1142-1146.
6. S. R. Bishop, K. L. Duncan and E. D. Wachsman, *Acta Materialia*, 2009, **57**, 3596-3605.
7. S. Wang, H. Inaba, H. Tagawa and T. Hashimoto, *Journal of The Electrochemical Society*, 1997, **144**, 4076-4080.
8. V. P. Gorelov, V. B. Balakireva, I. Y. Yaroslavtsev, V. A. Kazantsev and E. G. Vaganov, *Russian Journal of Electrochemistry*, 2007, **43**, 888-893.
9. S. Wang, E. Oikawa and T. Hashimoto, *Journal of The Electrochemical Society*, 2004, **151**, E46.
10. Y. Li, E. R. Maxey, J. W. Richardson Jr, B. Ma, T. H. Lee and S.-J. Song, *Journal of the American Ceramic Society*, 2007, **90**, 1208-1214.
11. S. R. Bishop, T. Nakamura and K. Amezawa, *Solid State Ionics*, 2014, **261**, 1-4.
12. T. R. Armstrong, J. W. Stevenson, L. R. Pederson and P. E. Raney, *Journal of The Electrochemical Society*, 1996, **143**, 2919-2925.
13. F. Boroomand, E. Wessel, H. Bausinger and K. Hilpert, *Solid State Ionics*, 2000, **129**, 251-258.
14. P. H. Larsen, P. V. Hendriksen and M. Mogensen, *Journal of thermal analysis*, 1997, **49**, 1263-1275.
15. R. Kriegel, R. Kircheisen and J. Töpfer, *Solid State Ionics*, 2010, **181**, 64-70.
16. M. G. Sahini, J. R. Tolchard, K. Wiik and T. Grande, *Dalton Transactions*, 2015, **44**, 10875-10881.
17. A. A. Yaremchenko, S. M. Mikhalev, E. S. Kravchenko and J. R. Frade, *Journal of the European Ceramic Society*, 2014, **34**, 703-715.
18. S. McIntosh, J. F. Vente, W. G. Haije, D. H. A. Blank and H. J. M. Bouwmeester, *Chemistry of Materials*, 2006, **18**, 2187-2193.
19. A. A. Yaremchenko, E. V. Tsipis, A. V. Kovalevsky, J. C. Waerenborgh and V. V. Kharton, *Solid State Ionics*, 2011, **192**, 259-268.
20. O. Valentin, F. Millot, É. Blond, N. Richet, A. Julian, E. Véron and S. Ory, *Solid State Ionics*, 2011, **193**, 23-31.
21. C. S. Kim, N. H. Perry, S. R. Bishop and H. L. Tuller, *Journal of Electroceramics*, 2018, **40**, 332-337.
22. N. H. Perry, J. J. Kim, S. R. Bishop and H. L. Tuller, *Journal of Materials Chemistry A*, 2015, **3**, 3602-3611.
23. C. Y. Park and A. J. Jacobson, *Solid State Ionics*, 2005, **176**, 2671-2676.
24. S. I. Elkalashy, T. V. Aksenova, A. S. Urusova and V. A. Cherepanov, *Solid State Ionics*, 2016, **295**, 96-103.
25. T. V. Aksenova, A. E. Vakhromeeva, S. I. Elkalashy, A. S. Urusova and V. A. Cherepanov, *Journal of Solid State Chemistry*, 2017, **251**, 70-78.
26. H. Bae, B. Singh, L. Mathur, J. H. Joo and S.-J. Song, *Journal of The Electrochemical Society*, 2021, **168**, 034511.
27. V. V. Sereda, D. S. Tsvetkov, I. L. Ivanov and A. Y. Zuev, *Acta Materialia*, 2019, **162**, 33-45.
28. V. V. Kharton, A. A. Yaremchenko, M. V. Patrakeev, E. N. Naumovich and F. M. B. Marques, *Journal of the European Ceramic Society*, 2003, **23**, 1417-1426.
29. A. Fossdal, M. Menon, I. Wærnhus, K. Wiik, M.-A. Einarsrud and T. Grande, *Journal of the American Ceramic Society*, 2004, **87**, 1952-1958.
30. H. Bae, J. Hong, B. Singh, A. K. Srivastava, J. H. Joo and S.-J. Song, *Journal of The Electrochemical Society*, 2019, **166**, F180-F189.
31. M. Kuhn, S. Hashimoto, K. Sato, K. Yashiro and J. Mizusaki, *Solid State Ionics*, 2011, **195**, 7-15.

32. C. de Leeuwe, W. Hu, D. Neagu, E. I. Papaioannou, S. Pramana, B. Ray, J. S. O. Evans and I. S. Metcalfe, *Journal of Solid State Chemistry*, 2021, **293**, 121838.
33. H. Bae, B. Singh, I.-H. Kim, H.-N. Im and S.-J. Song, *Journal of The Electrochemical Society*, 2018, **165**, F641-F651.
34. M. Kuhn, S. Hashimoto, K. Sato, K. Yashiro and J. Mizusaki, *Solid State Ionics*, 2013, **241**, 12-16.
35. S. R. Bishop, K. L. Duncan and E. D. Wachsman, *Journal of the American Ceramic Society*, 2010, **93**, 4115-4121.
36. S. B. Adler, *Journal of the American Ceramic Society*, 2001, **84**, 2117-2119.
37. S.-i. Hashimoto, Y. Fukuda, M. Kuhn, K. Sato, K. Yashiro and J. Mizusaki, *Solid State Ionics*, 2011, **186**, 37-43.
38. S. Wang, M. Katsuki, M. Dokiya and T. Hashimoto, *Solid State Ionics*, 2003, **159**, 71-78.
39. H. L. Lein, K. Wiik and T. Grande, *Solid State Ionics*, 2006, **177**, 1795-1798.
40. M.-B. Choi, S.-Y. Jeon, B. Singh, Y.-S. Yoo, J.-H. Hwang and S.-J. Song, *Acta Materialia*, 2014, **65**, 373-382.
41. Chen, Yu and S. B. Adler, *Chemistry of Materials*, 2005, **17**, 4537-4546.
42. A. Y. Zuev, A. I. Vylkov, A. N. Petrov and D. S. Tsvetkov, *Solid State Ionics*, 2008, **179**, 1876-1879.
43. P. Hjalmarsson, M. Søgaard and M. Mogensen, *Journal of Solid State Chemistry*, 2010, **183**, 1853-1862.
44. C. Bernuy-Lopez, K. Høydalsvik, M.-A. Einarsrud and T. Grande, *Materials*, 2016, **9**, 154-151–154-118.
45. D. A. Malyshkin, A. Y. Novikov, V. V. Sereda, I. L. Ivanov, D. S. Tsvetkov and A. Y. Zuev, *Inorganic Chemistry*, 2018, **57**, 12409-12416.
46. D. Malyshkin, A. Novikov, D. Tsvetkov and A. Zuev, *Materials Letters*, 2018, **229**, 324-326.
47. R. A. Cox-Galhotra, A. Huq, J. P. Hodges, C. Yu, X. Wang, W. Gong, A. J. Jacobson and S. McIntosh, *Solid State Ionics*, 2013, **249-250**, 34-40.
48. D. S. Tsvetkov, I. L. Ivanov, D. A. Malyshkin and A. Y. Zuev, *Dalton Transactions*, 2014, **43**, 11862-11866.
49. A. L. Sednev-Lugovets, V. V. Sereda, D. A. Malyshkin, D. S. Tsvetkov, I. L. Ivanov, A. Y. Zuev and A. Maignan, *The Journal of Chemical Thermodynamics*, 2021, **161**, 106523.
50. I. Szpunar, R. Strandbakke, M. H. Sørby, S. L. Wachowski, M. Balaguer, M. Tarach, J. M. Serra, A. Witkowska, E. Dzik, T. Norby, M. Gazda and A. Mielewczyk-Gryń, *Materials*, 2020, **13**, 4044.
51. R. A. Cox-Galhotra, A. Huq, J. P. Hodges, J.-H. Kim, C. Yu, X. Wang, A. J. Jacobson and S. McIntosh, *Journal of Materials Chemistry A*, 2013, **1**, 3091-3100.
52. A. Chatterjee, J. M. Caicedo, B. Ballesteros and J. Santiso, *Journal of Materials Chemistry A*, 2018, **6**, 12430-12439.
53. L. Mogni, F. Prado, C. Jiménez and A. Caneiro, *Solid State Ionics*, 2013, **240**, 19-28.
54. D. S. Tsvetkov, I. L. Ivanov, D. Malyshkin, V. V. Sereda and A. Y. Zuev, *ECS Transactions*, 2016, **72**, 21-35.
55. P. Karen, *Journal of Solid State Chemistry*, 2021, **299**, 122147.
56. P. Karen and P. M. Woodward, *Journal of Materials Chemistry*, 1999, **9**, 789-797.
57. P. Karen, P. M. Woodward, P. N. Santhosh, T. Vogt, P. W. Stephens and S. Pagola, *Journal of Solid State Chemistry*, 2002, **167**, 480-493.
58. J. Lindén, P. Karen, A. Kjekshus, J. Miettinen, T. Pietari and M. Karppinen, *Physical Review B*, 1999, **60**, 15251-15260.
59. J. Nakamura, J. Lindén, H. Yamauchi and M. Karppinen, *Solid State Communications*, 2002, **121**, 269-274.
60. P. Karen, K. Gustafsson and J. Lindén, *Journal of Solid State Chemistry*, 2007, **180**, 148-157.
61. P. Karen, *Journal of Solid State Chemistry*, 2003, **170**, 9-23.
62. V. S. Kudyakova, A. M. Shalamova, B. V. Politov and A. Y. Suntsov, *Journal of Alloys and Compounds*, 2021, **886**, 161133.
63. A. C. Tomkiewicz, M. A. Tamimi, A. Huq and S. McIntosh, *Journal of Power Sources*, 2016, **330**, 240-245.
64. R. Kircheisen and J. Töpfer, *Journal of Solid State Chemistry*, 2012, **185**, 76-81.

65. S. R. Bishop, D. Marrocchelli, C. Chatzichristodoulou, N. H. Perry, M. B. Mogensen, H. L. Tuller and E. D. Wachsman, *Annual Review of Materials Research*, 2014, **44**, 205-239.
66. T. Nakamura, Y. Ling and K. Amezawa, *Journal of Materials Chemistry A*, 2015, **3**, 10471-10479.
67. V. A. Cherepanov, T. V. Aksenova, L. Y. Gavrilova and K. N. Mikhaleva, *Solid State Ionics*, 2011, **188**, 53-57.
68. J. Lindén, M. Kochi, K. Lehmus, T. Pietari, M. Karppinen and H. Yamauchi, *Journal of Solid State Chemistry*, 2002, **166**, 118-127.
69. A. I. Klyndyuk, *Physics of the Solid State*, 2008, **50**, 609.