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APPENDICES

APPENDIX A

Tolerance number

Goldschmidt (1926) defined the tolerance limits of the size of ions through a tolerance factor, t as Equation (A.1)

$$t = (r_A + r_O)/ [\sqrt{2} (r_B + r_O)] \quad (A.1)$$

where r_A, r_B, and r_O are the radii of respective ions. For the substituted perovskite at A and B site, $A_{1-x}A'_xB_{1-y}B'_yO_{3-\delta}$, r_A and r_B were calcuated from the sum of each metal at A site and B site, respectively, time its compostition. The atomic weight, ionic charge, coordination number, and ionic radius of all concerned metals were shown in Table A.1

Table A.1 Atomic weight, ionic charge, coordination number, and ionic radius of concerned metals

Metal	Atomic weight	Ionic charge	Coordination No.	Ionic radius (Å)
La	138.92	3+	12	1.36
Fe	55.85	3+	6	0.55
Ga	69.72	3+	6	0.62
Ba	137.36	2+	12	1.61
Sr	87.62	2+	12	1.44
Co	58.94	2+	6	0.65
O	16.00	2-	6	1.40

Therefore, as Equation A.1 the tolerance number of perovskite compounds such as LSGF 6428 was calculated as below.

$$\text{tolerance number of LSGF6428} = \frac{1.36*0.6+1.44*0.4+1.40}{\sqrt{2}\,(0.55*0.8+0.62*0.2+1.40)}$$

$$= 1.01$$

Bulk density

Bulk density (D) can be calculated form mass and volume as showed in Equation (A.2)

$$D = Mass/ \pi R^2 * h \qquad (A.2)$$

Where R is the radius and h is the thickness of membrane

APPENDIX B

Synthesis of perovskite compounds

The experimental conditions and data for the synthesis of all perovskite compounds were shown in Table B-1 and Table B-2

Table B-1 List of the experimental conditions and data of the substrate and catalytic perovskite compounds

Substrate perovskites	Solution (Nitric acid)	Color of solution and appearance changing during titration	Calcined temp. (^{o}C)	pH	Material feature
LSCF 8264	Yellow	Dark brown to yellow to precipitate to clear brown	800	9.03	Fluffy yellow and black powder
LSGF 6437	Yellow	Dark brown to yellow to precipitate to clear brown	1000	8.98	Fluffy yellow and gray powder
BSCF 5582	Orange-pink	Dark purple to bright purple precipitate to clear purple	1000	9.19	Fluffy brown and black powder

Table B-2 List of the experimental conditions and data catalytic perovskite compounds

Catalytic perovskites	Solution (Nitric acid)	Color of solution and appearance changing during titration	pH	Material feature
LSC 82	Pink	Orange-pink to red-purple to purple to precipitate to clear purple	9.19	Fluffy brown and black powder
LSC 73	Pink	Orange-pink to red-purple to purple to precipitate to clear purple	9.07	Fluffy brown and black powder

Table B-2 (Cont.) List of the experimental conditions and data catalytic perovskite compounds

LSC 64	Pink	Orange-pink to red-purple to purple to precipitate to clear purple	9.18	Fluffy brown and black powder
LSC 55	Pink	Orange-pink to red-purple to purple to precipitate to clear purple	9.18	Fluffy brown and black powder
LSC 46	Pink	Orange-pink to red-purple to purple to precipitate to clear purple	9.20	Fluffy brown and black powder
LSF 82	Yellow	Brown to greenish yellow to precipitate to clear brown	9.13	Fluffy brown and black powder
LSF 73	Yellow	Brown to greenish yellow to precipitate to clear brown	9.07	Fluffy brown and black powder
LSF 64	Yellow	Brown to greenish yellow to precipitate to clear brown	9.00	Fluffy brown and black powder
LSF 55	Yellow	Brown to greenish yellow to precipitate to clear brown	9.19	Fluffy brown and black powder
LSF 46	Yellow	Brown to greenish yellow to precipitate to clear brown	9.11	Fluffy brown and black powder
BSC 82	Pink	Orange-pink to pink to orange to clear purple	9.20	Black powder
BSC 73	Pink	Orange-pink to pink to orange to clear purple	9.16	Black powder
BSC 64	Pink	Orange-pink to pink to orange to clear purple	9.01	Black powder
BSC 55	Pink	Orange-pink to pink to orange to clear purple	9.05	Black powder
BSC 46	Pink	Orange-pink to pink to orange to clear purple	9.03	Black powder
BSF 82	Yellow	Yellow to brown to greenish yellow to precipitate to clear brown	9.11	Brown powder

Table B-2 (Cont.) List of the experimental conditions and data catalytic perovskite compounds

BSF 73	Yellow	Yellow to brown to greenish yellow to precipitate to clear brown	9.13	Brown powder
BSF 64	Yellow	Yellow to brown to greenish yellow to precipitate to clear brown	9.19	Brown powder
BSF 55	Yellow	Yellow to brown to greenish yellow to precipitate to clear brown	9.13	Brown powder
BSF 46	Yellow	Yellow to brown to greenish yellow to precipitate to clear brown	9.15	Brown powder

APPENDIX C

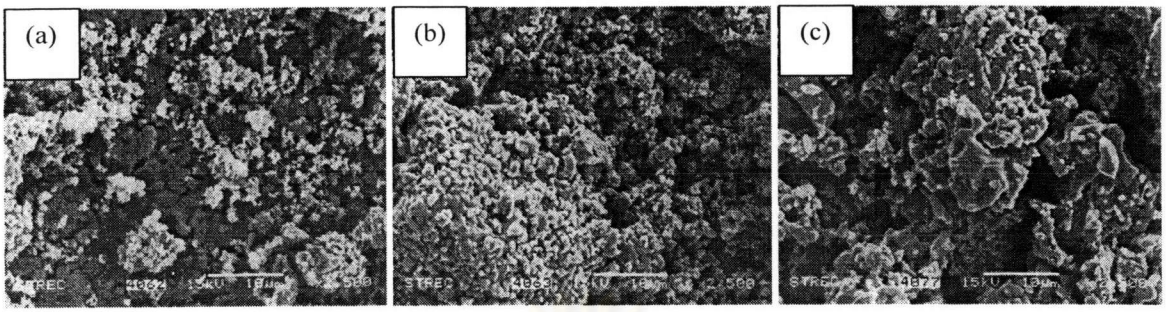

Figure C-1 SEM pictures of top view of LSC 55 layer coat on BSCF 5582 membrane sintered at (a) 800 C, 5h. (b) 1,000 C, 5h. (c) 1,100 C, 5h.

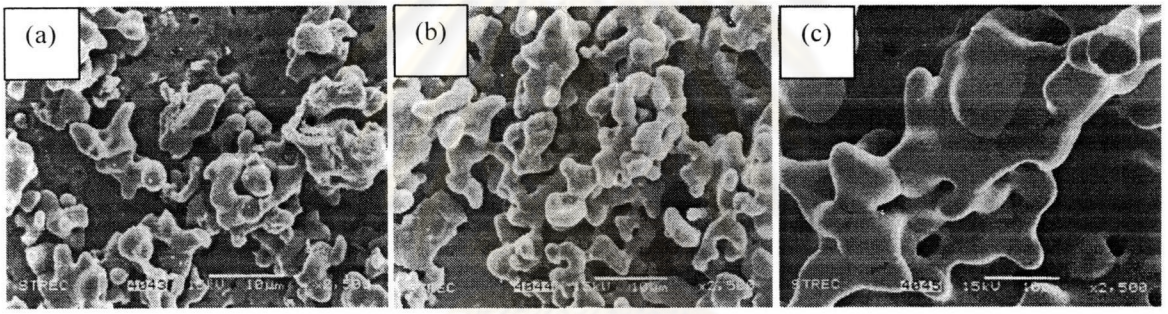

Figure C-2 SEM picture of top view BSC 46 layer coat on BSCF 5582 membrane sintered at (a) 800 ^{o}C, 5h. (b) 1,000 ^{o}C, 5h. (c) 1,100 ^{o}C, 5h.

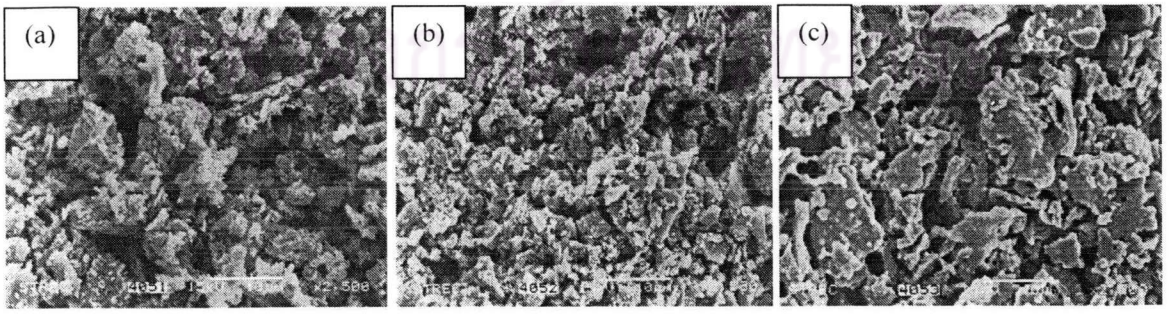

Figure C-3 SEM picture of top view of LSF 82 layer coat on BSCF 5582 membrane sintered at (a) 800 ^{o}C, 5h. (b) 1,000 ^{o}C, 5h. (c) 1,100 ^{o}C, 5h.

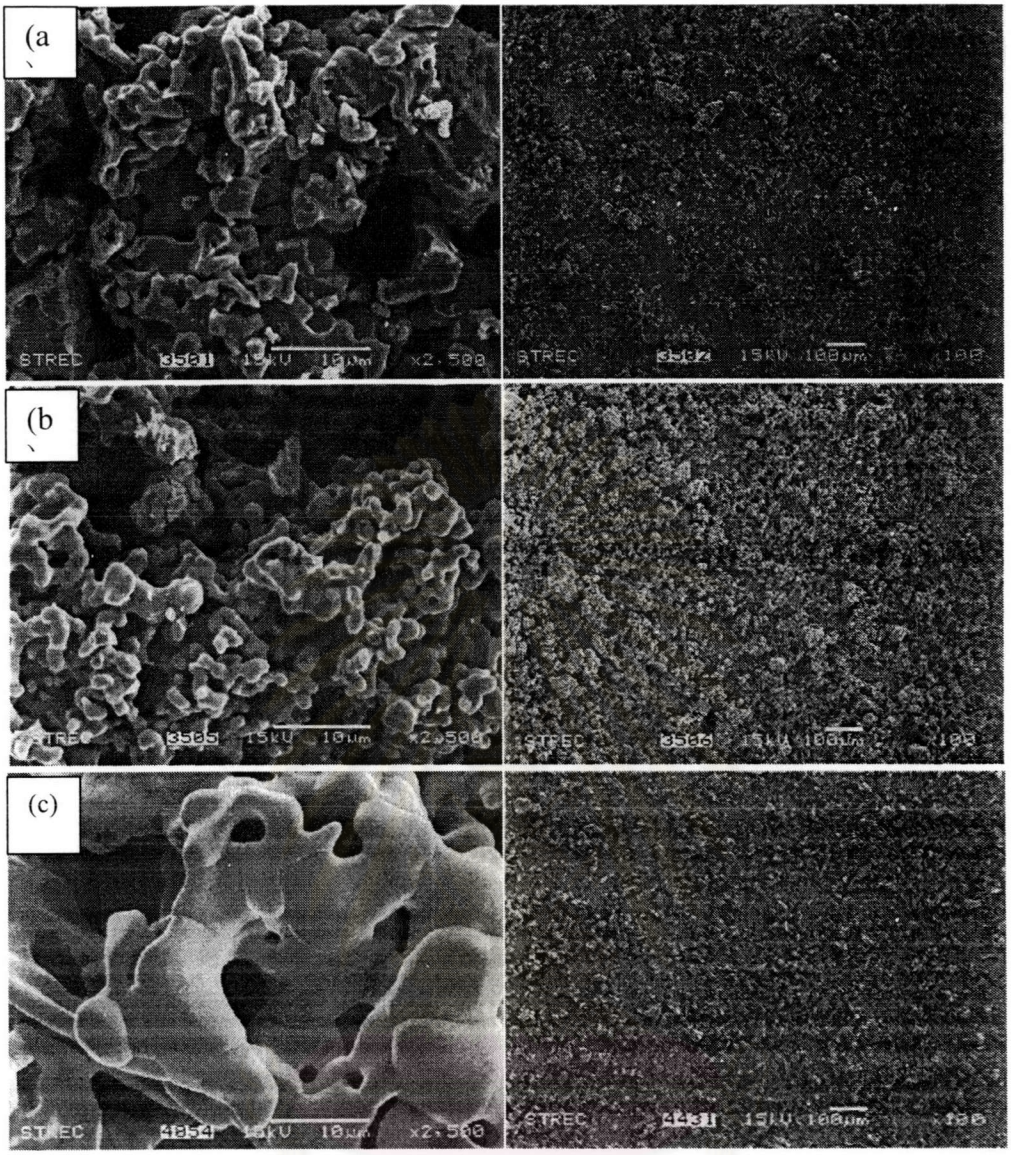

Figure C-4 SEM picture of top view BSC 55 layer coat on BSCF 5582 membrane sintered at (a) 800 ^{o}C, 5h. (b) 1,000 ^{o}C, 5h. (c) 1,100 ^{o}C, 5h.

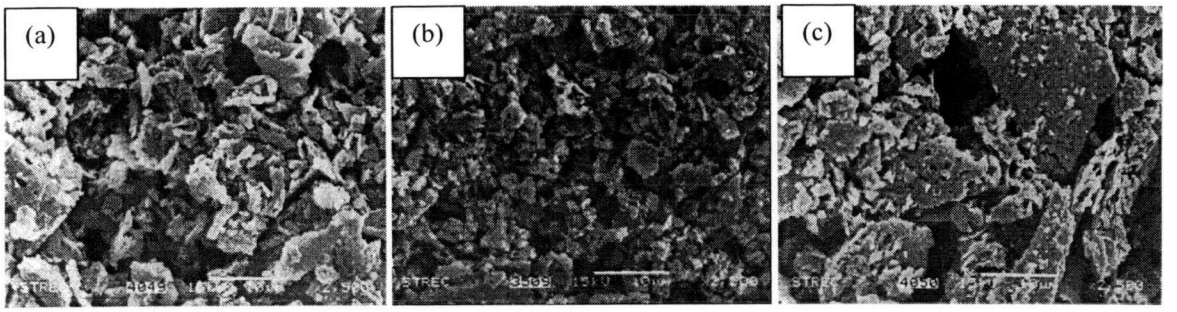

Figure C-6 SEM picture of top view of LSF 73 layer coat on BSCF 5582 membrane sintered at (a) 800 °C, 5h. (b) 1,000 °C, 5h. (c) 1,100 °C, 5 h.

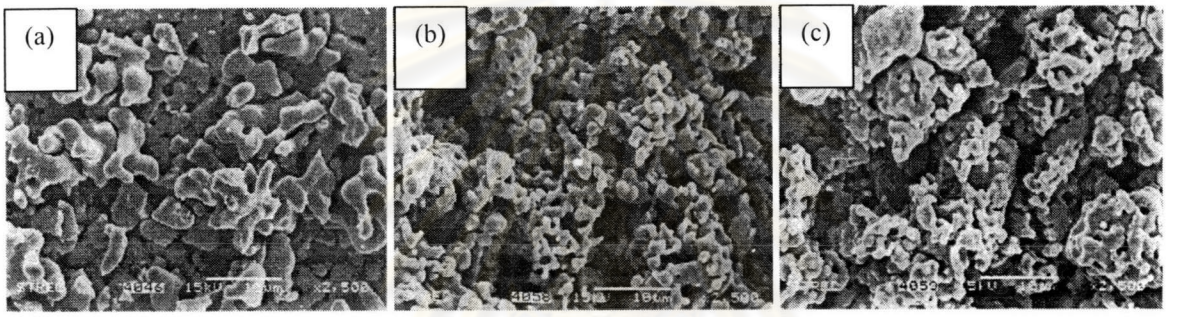

Figure C-8 SEM picture of top view of BSF 55 layer coat on BSCF 5582 membrane sintered at (a) 800 °C, 5h. (b) 1,000 °C, 5h. (c) 1,100 °C, 5 h.

APPENDIX D

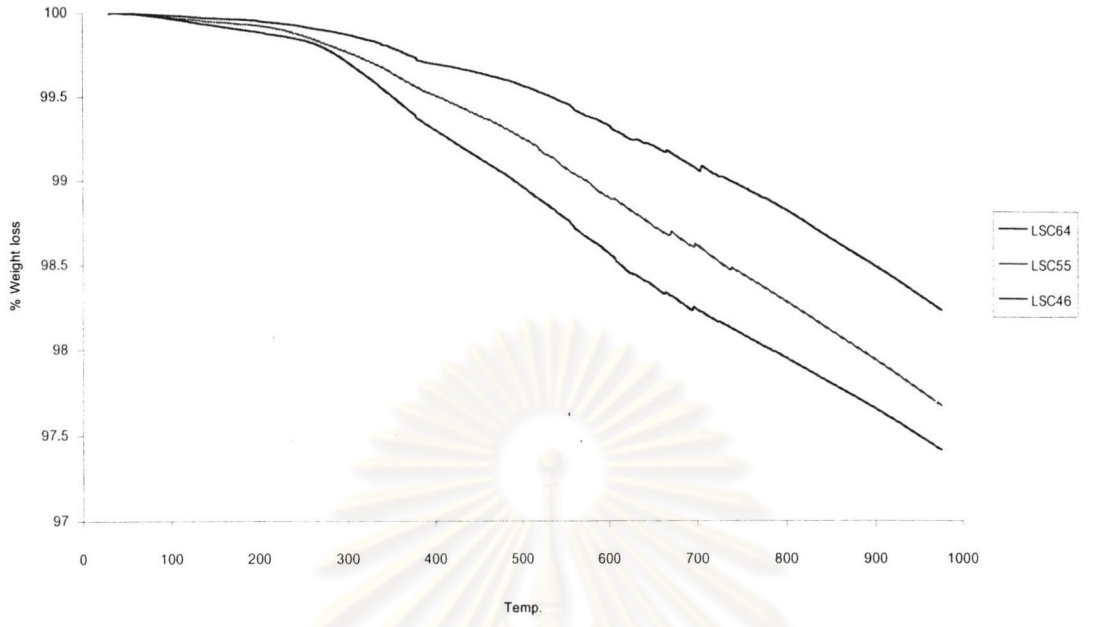

Figure D-1 TGA curves of the LSC compounds derived from the calcination condition for coated membrane.

Figure D-2 TGA curves of the LSF compounds derived from the calcination condition for coated membrane.

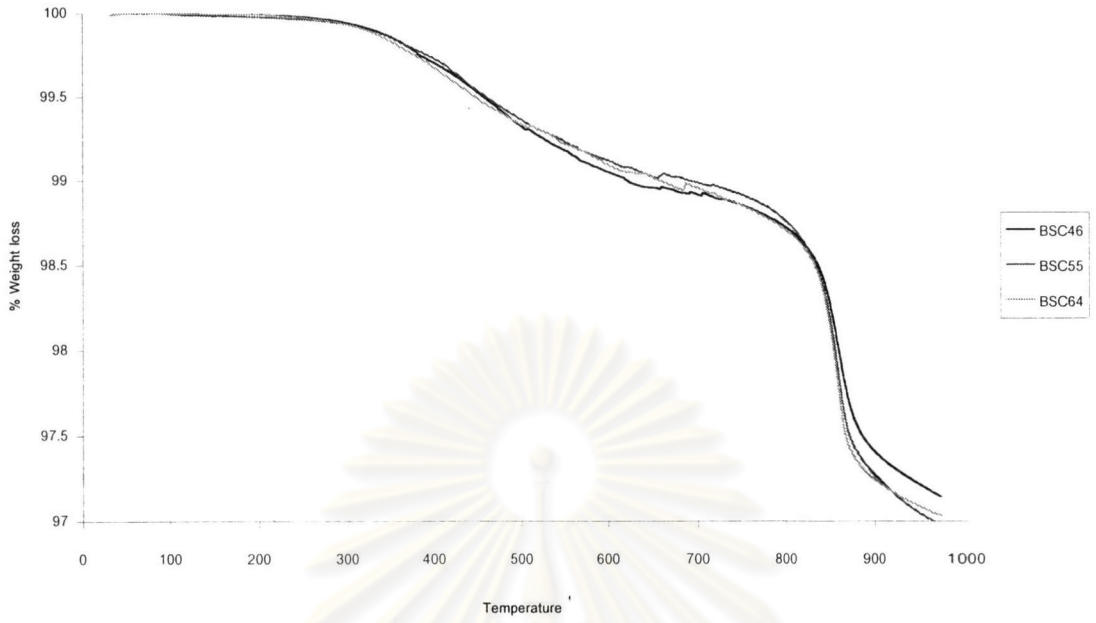

Figure D-3 TGA curves of the BSC compounds derived from the calcination condition for coated membrane.

Figure D-4 TGA curves of the BSF compounds derived from the calcination condition for coated membrane.

VITAE

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