Supplementary for

The A-site deficiency range identified for in-situ exsolution from $(La_{0.4}Sr_{0.6})_{1-\alpha}Ti_{0.95}Ni_{0.05}O_{3\pm\delta}$ electrodes for SOFC and SOEC.

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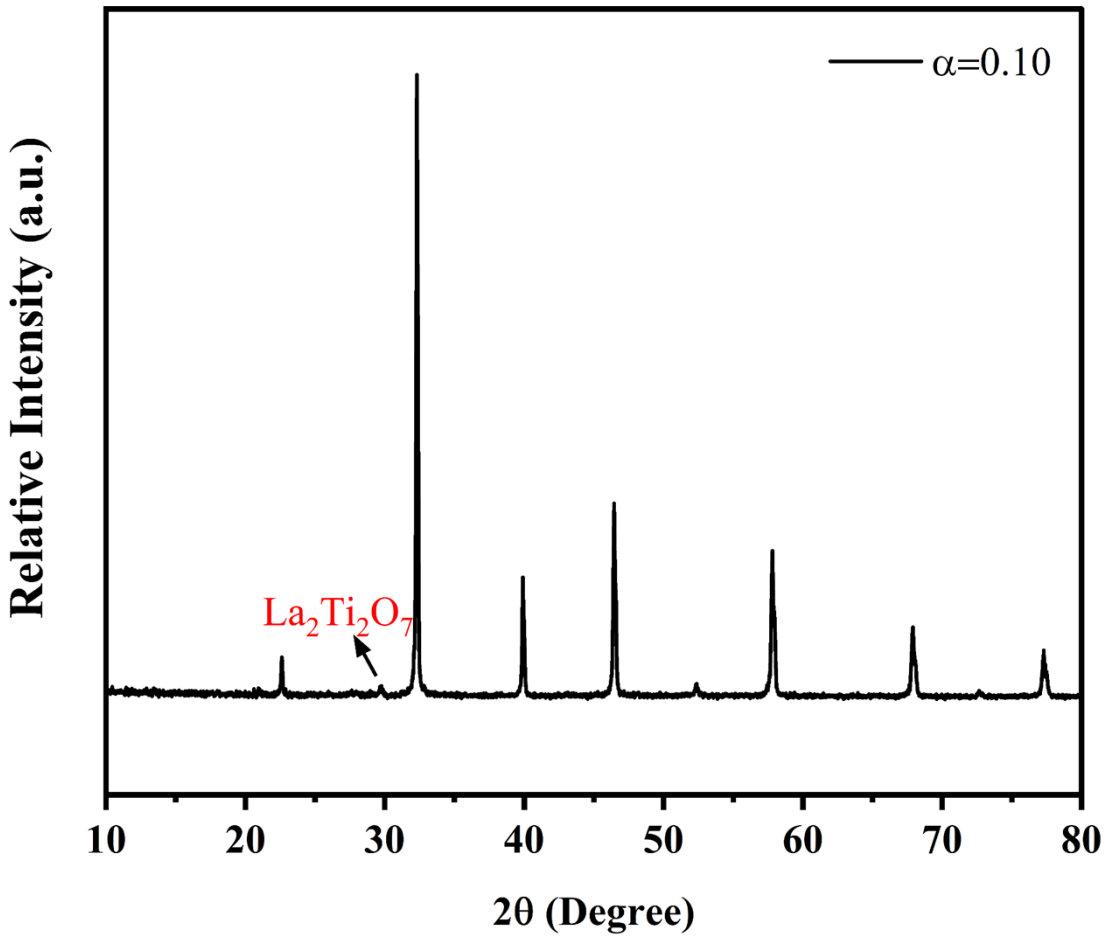

Fig. S1 XRD patterns of LSTN of α=0.10.

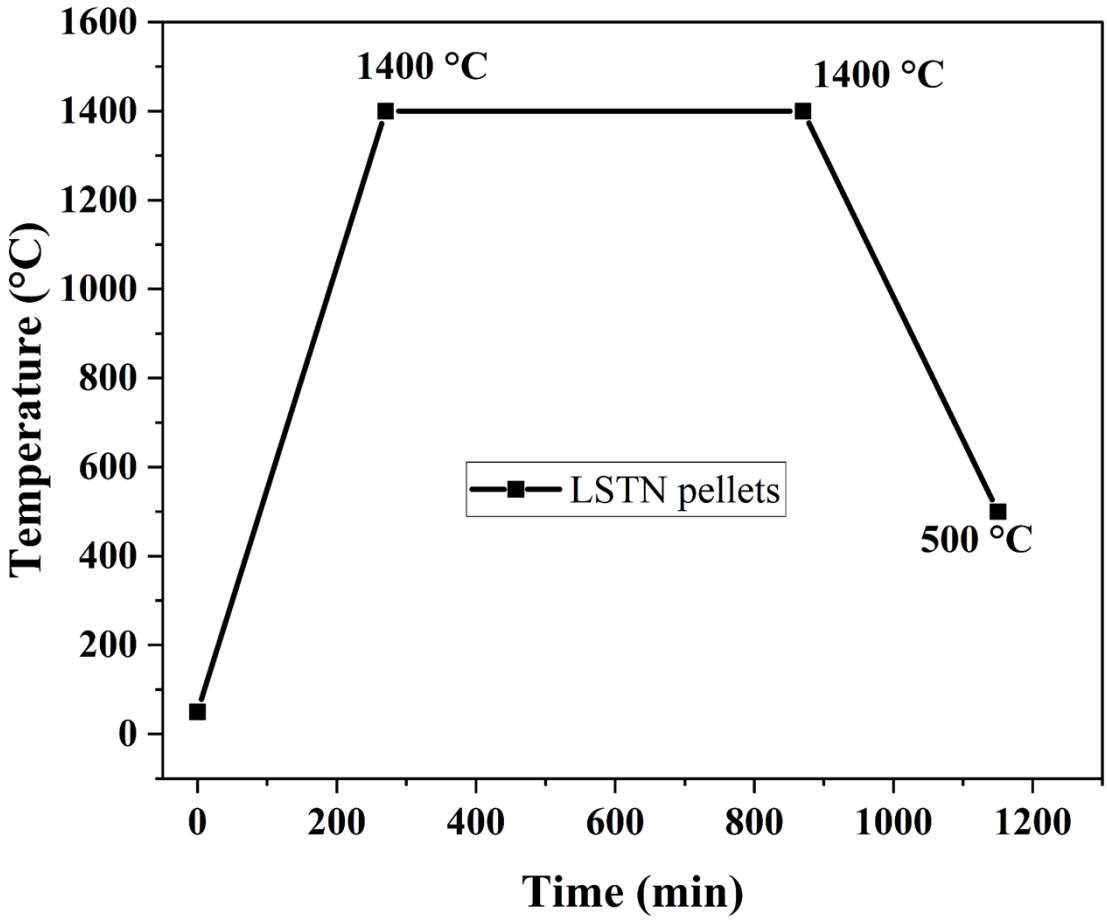

Fig. S2 Uniform sintering curves on samples characterised by sintering properties and conductivity of LSTN with different deficiencies.

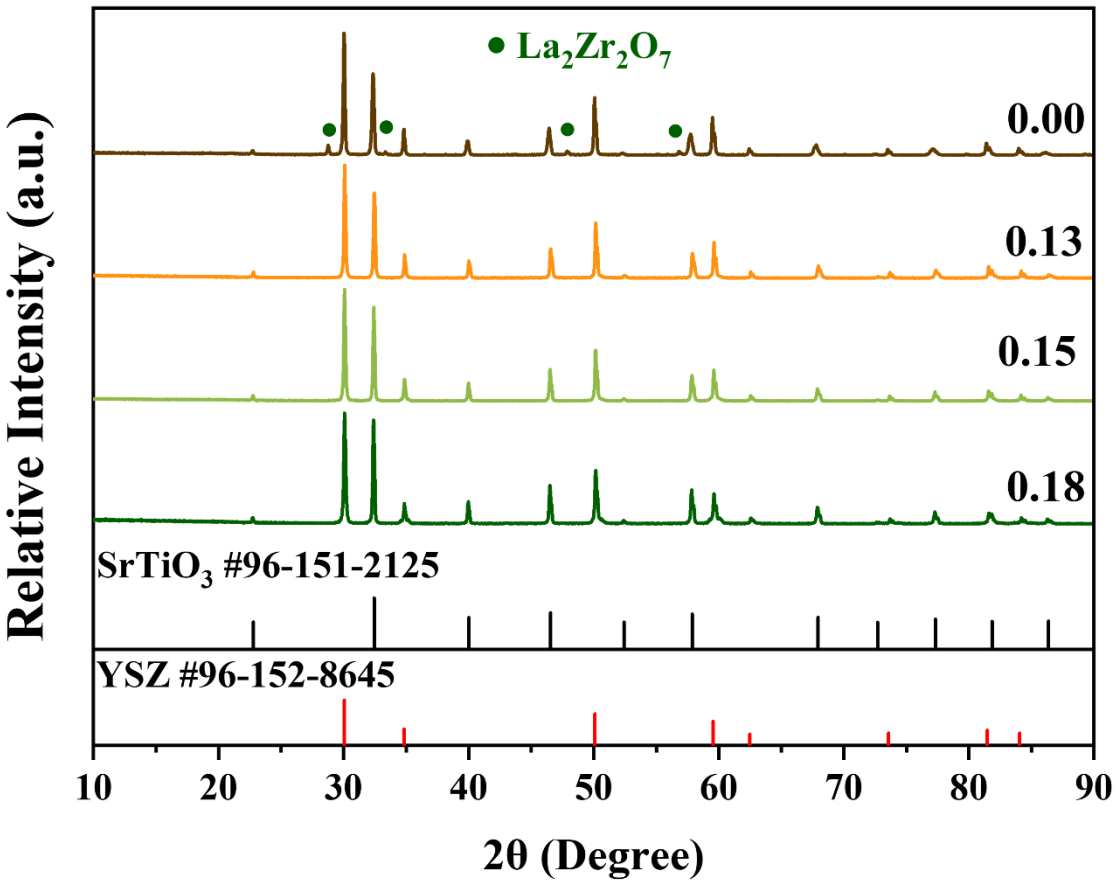

Fig. S3 XRD patterns of LSTN and YSZ mixed powders calcined at 1200 °C for 10 h

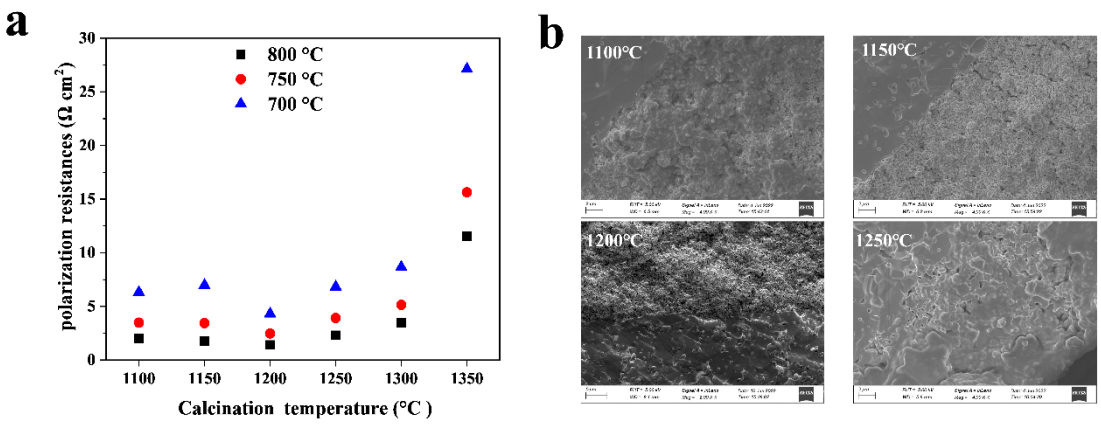

Fig. S4 Electrochemical performance optimization of LSTN-46-13 electrode at different calcination temperatures. (a) Polarization resistance

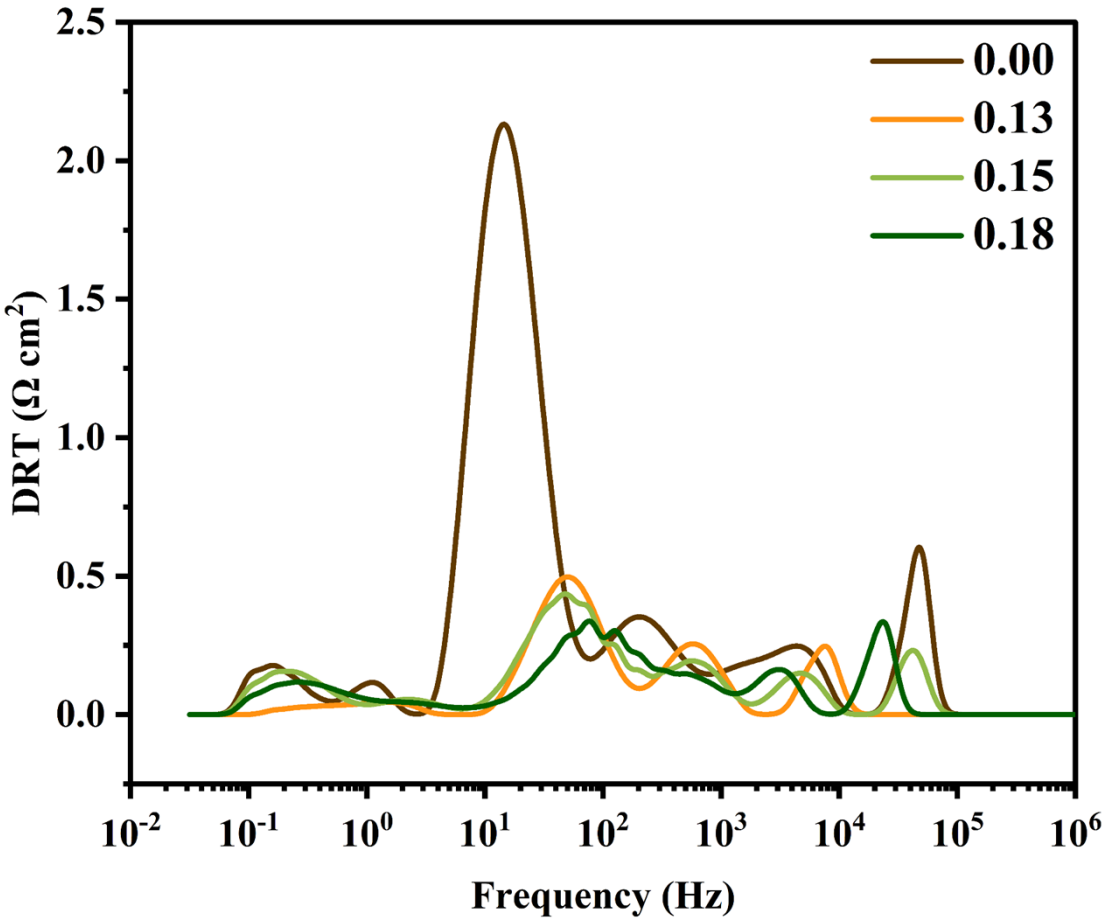

Fig. S5 DRT analysis of impedance spectra data for the LSTN cells at 800 ℃

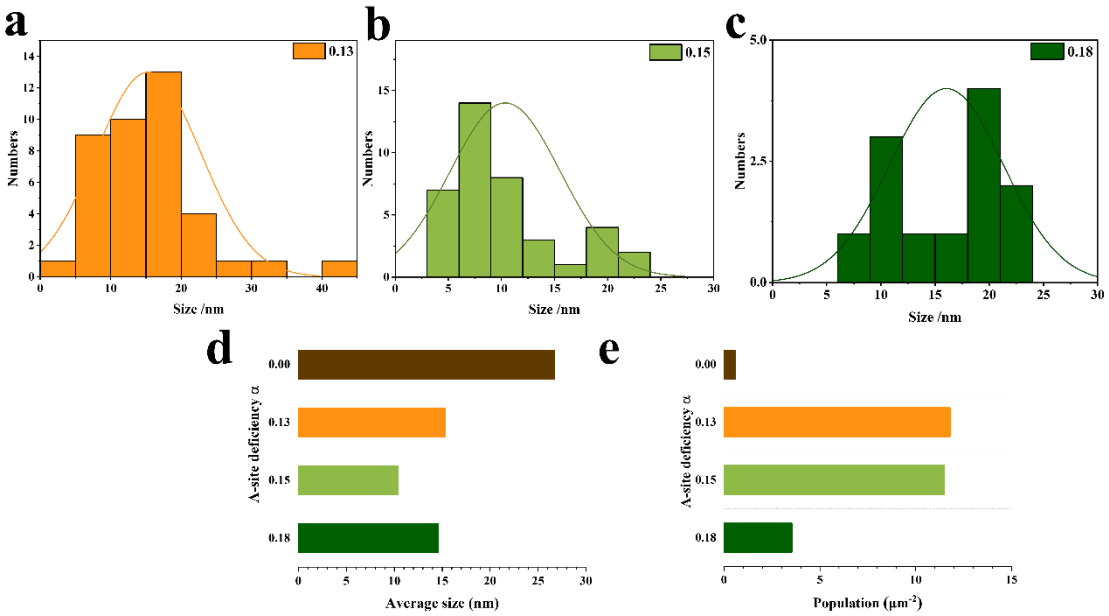

Fig. S6 Distributions of Ni NPs in LSTN samples after SOFC test (α value from 0.13 to 0.18), (a) α = 0.13, (b) α = 0.15, (c) α = 0.18. (d) The average size of Ni nanoparticles. (e) The population of Ni nanoparticles.

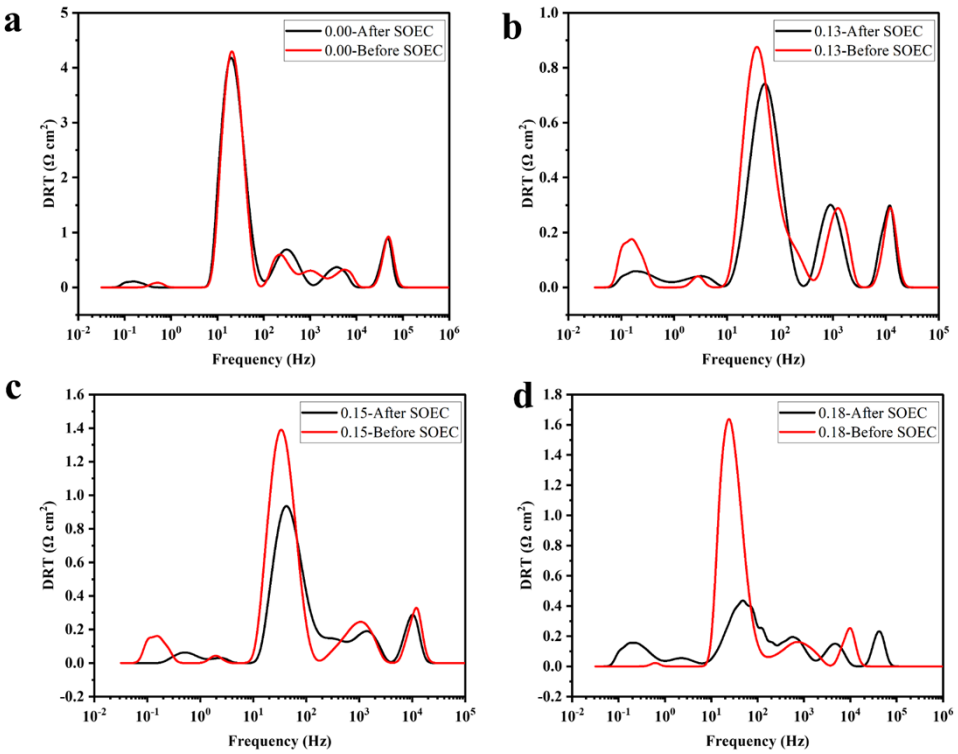

Fig. S7 DRT analysis of impedance spectra data before and after SOEC test for LSTN with different A site deficiency (α value from 0.00 to 0.18), (a) α = 0.00, (b)α = 0.13, (c) α = 0.15, (d) α = 0.18.

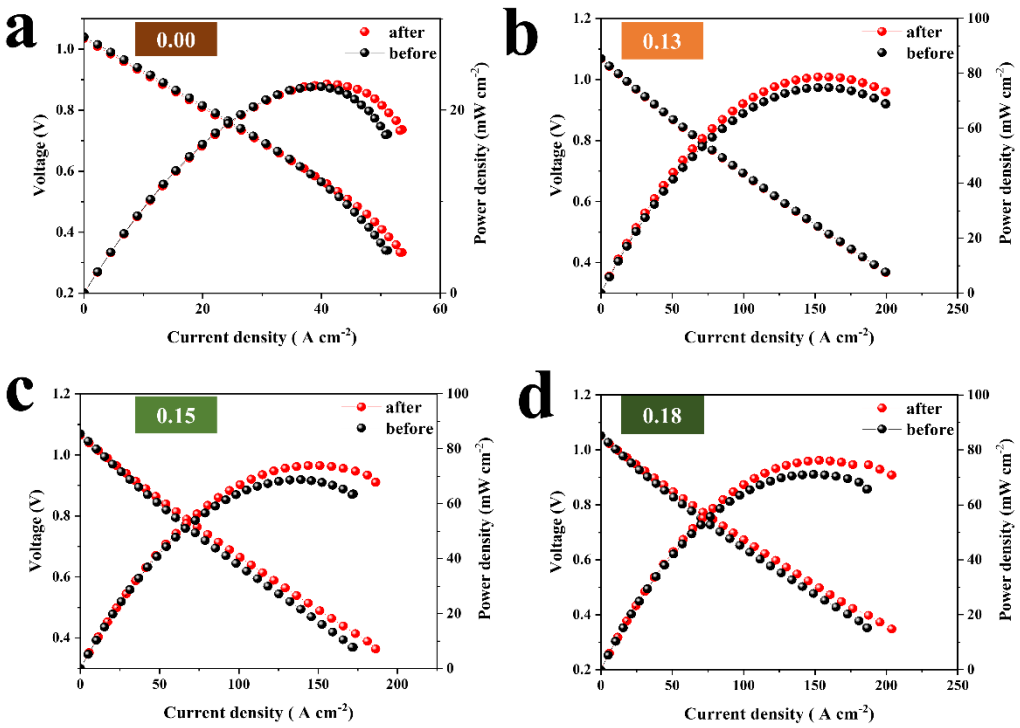

Fig. S8 The current–voltage curves (800 ° C, wet H_2) before and after SOEC test for LSTN with different A site deficiency (α value from 0.00 to 0.18), (a) α = 0.00, (b)α = 0.13, (c) α = 0.15, (d) α = 0.18.

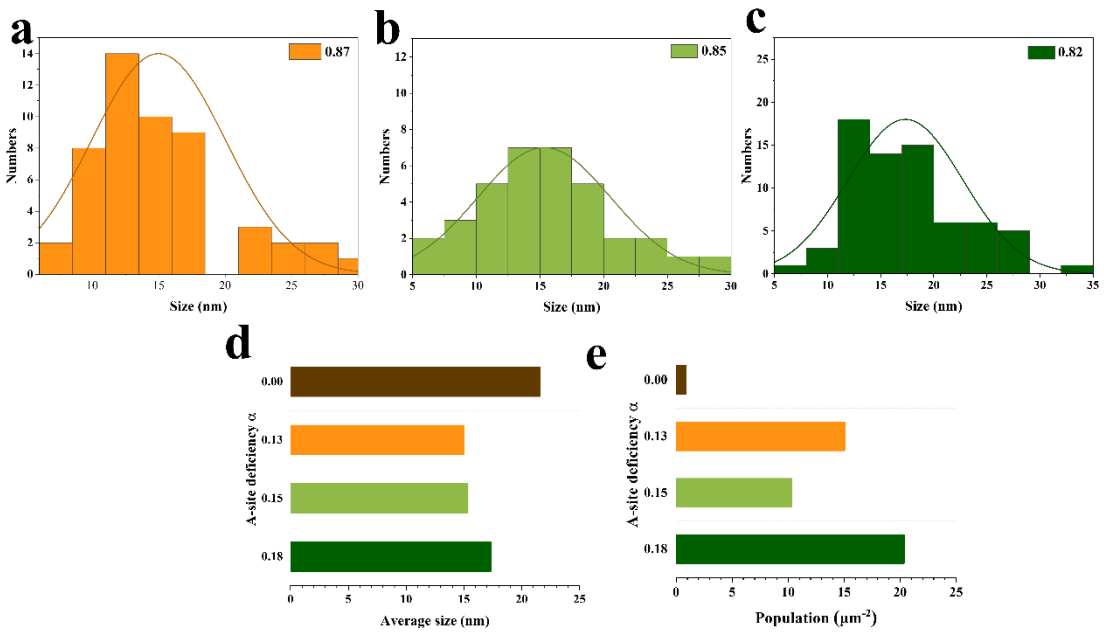

Fig. S9 The distributions of Ni NPs in LSTN samples after SOEC test (α value from 0.13 to 0.18), (a) α = 0.13, (b) α = 0.15, (c) α = 0.18. (d) The average diameter of Ni nanoparticles. (e) The population of Ni nanoparticles.

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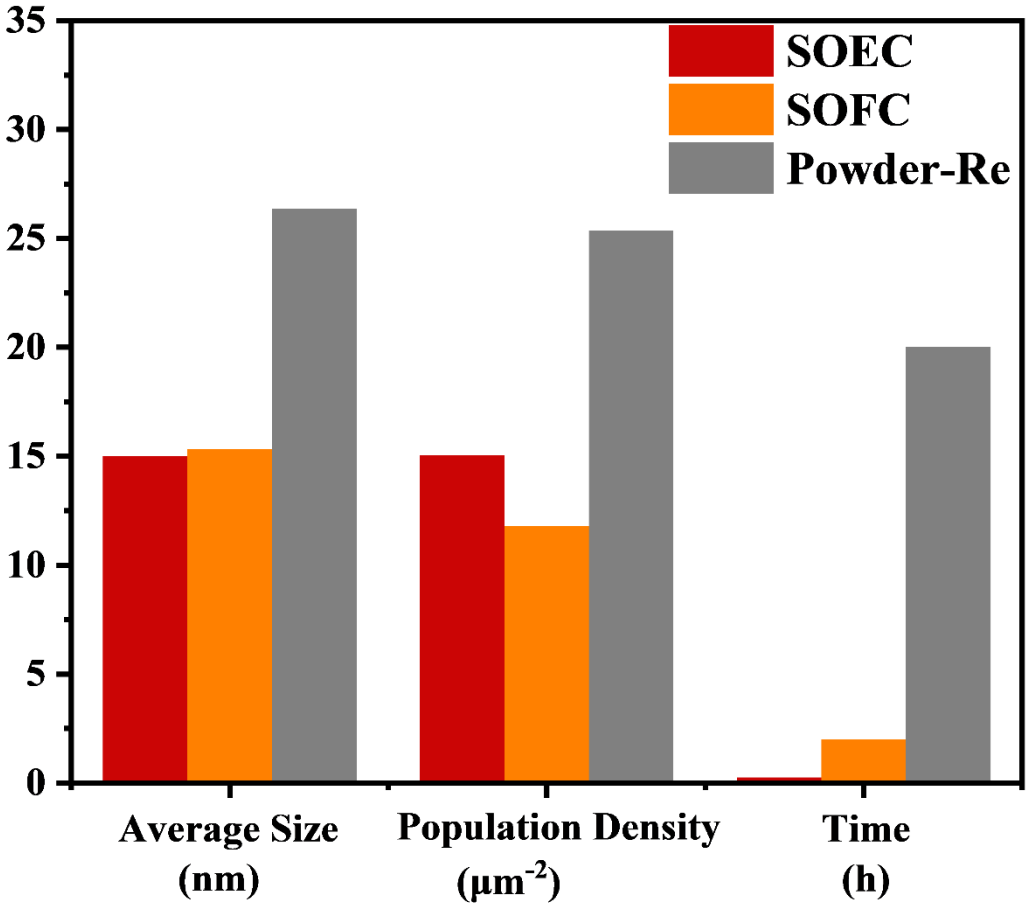

Fig. S10 Comparison of size, number and treatment time of Ni nanoparticles from different exsolution processes.