Supplementary Information for

Towards achieving ultrahigh thermal stability of fine-grained alumina fibers via segregation-induced ordered superstructures

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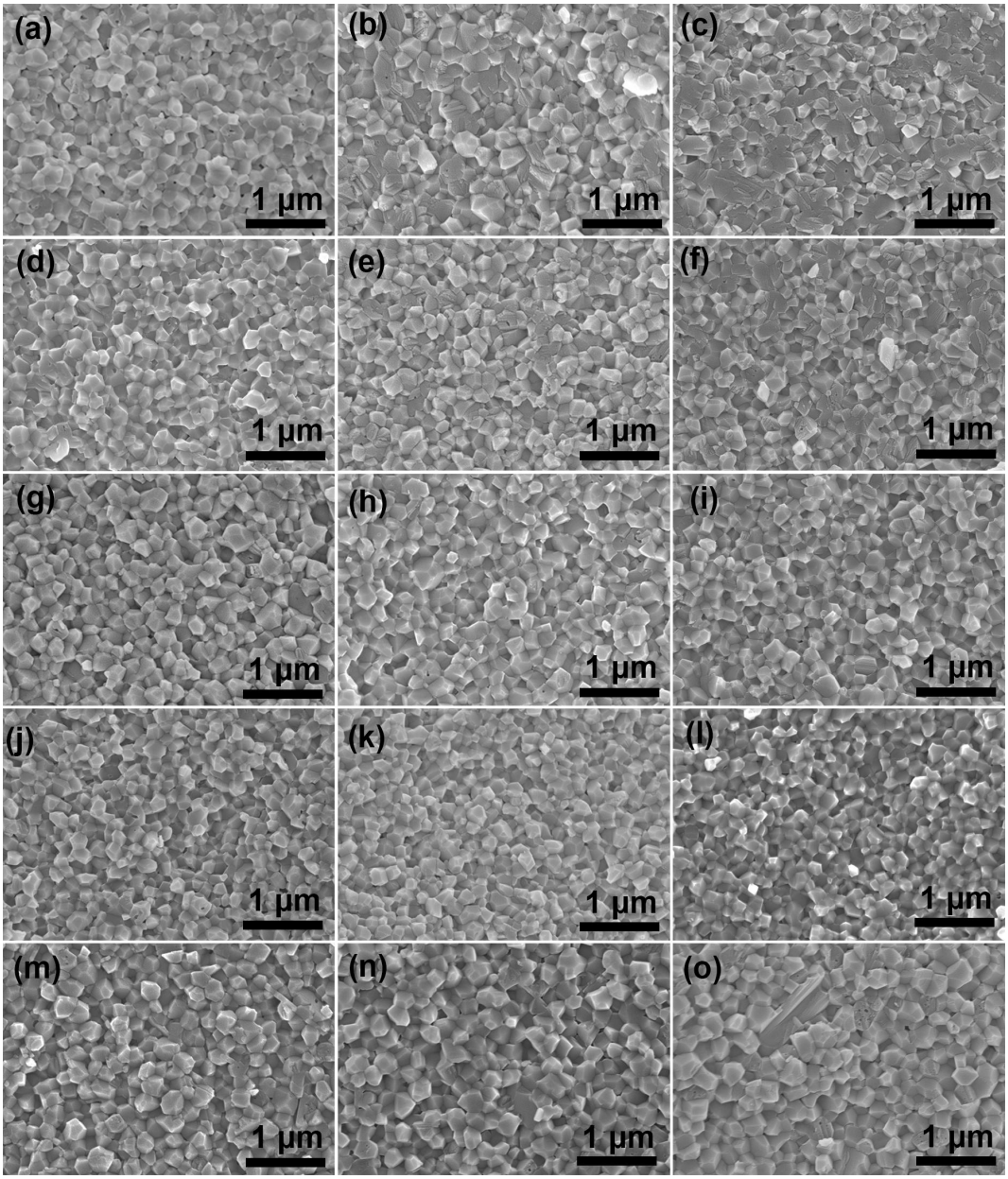
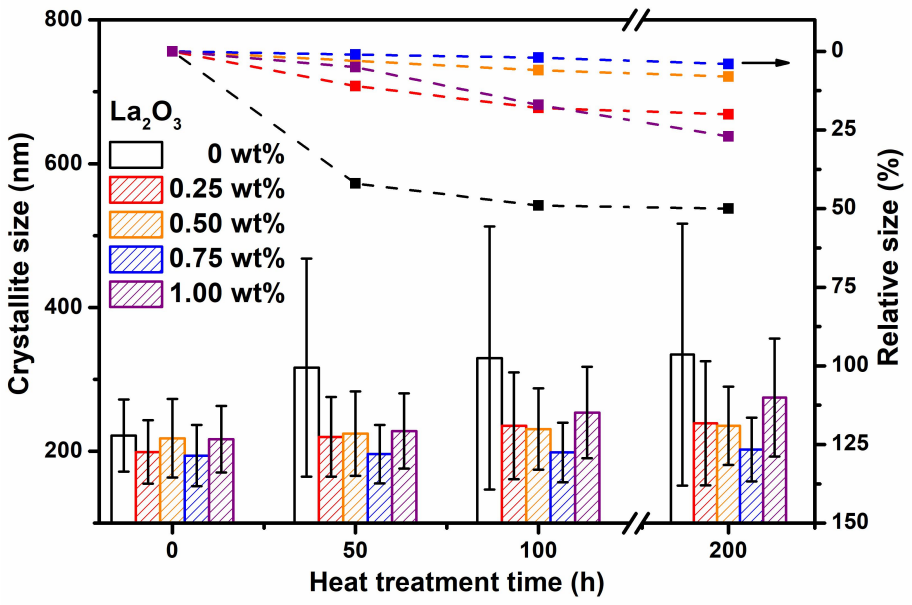
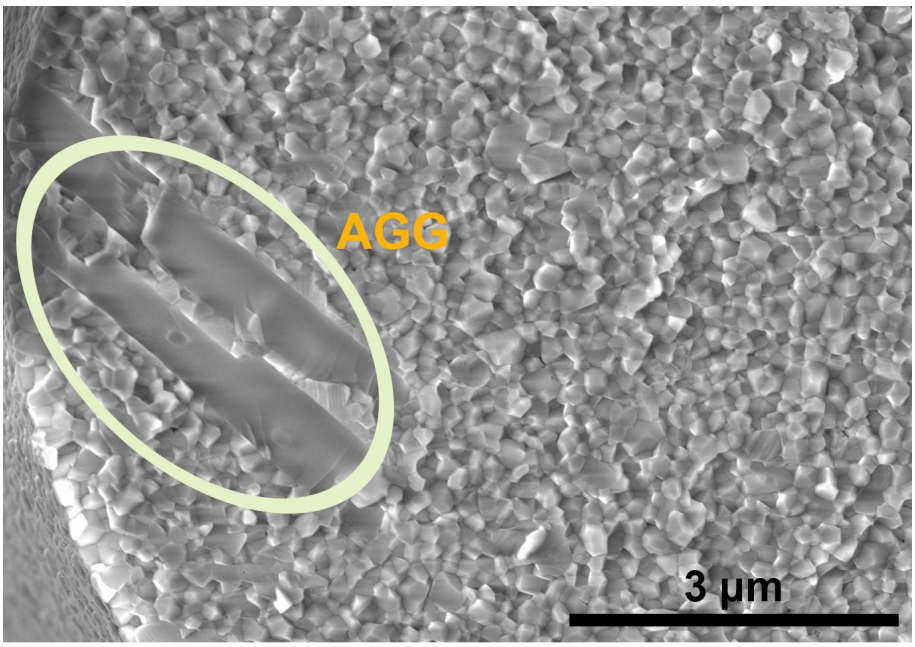


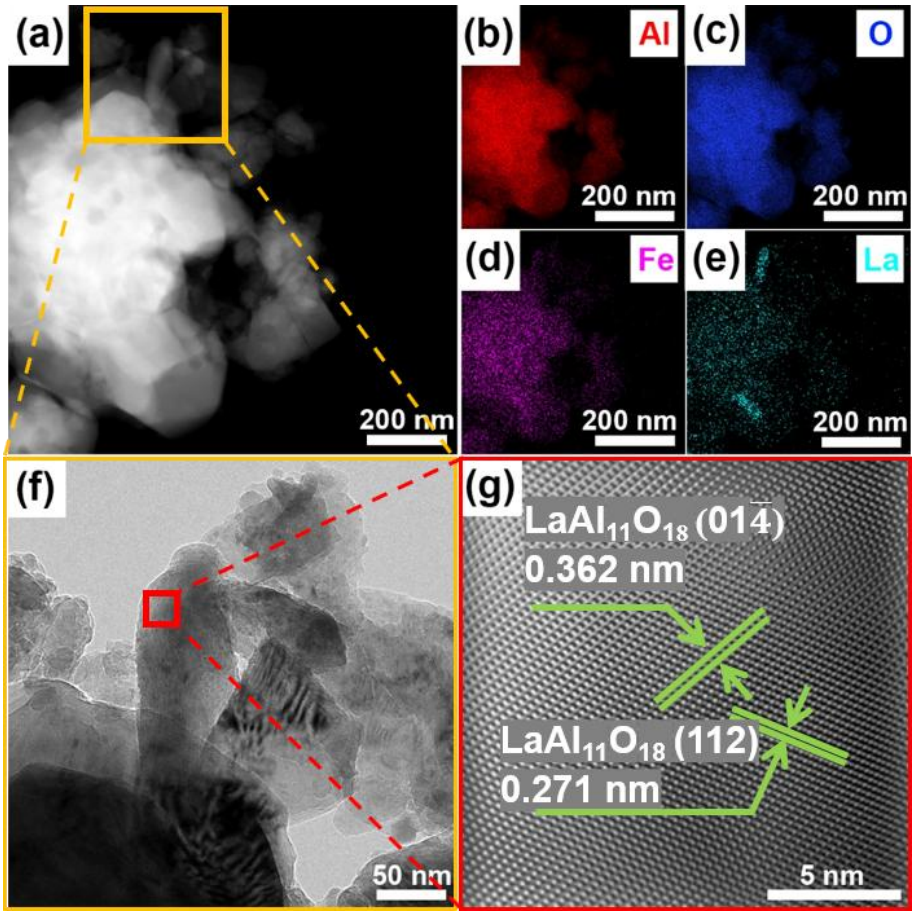
Supplementary Fig. 1 The fracture morphology of alumina fibers. (a-d) 0 wt.%, (e-h) 0.25 wt.%, (i-l) 0.5 wt.%, (m-p) 0.75 wt.% and (q-t) 1.0 wt.% La_2O_3 held at 1100 ℃ for 0 h, 50 h and 200 h, respectively.



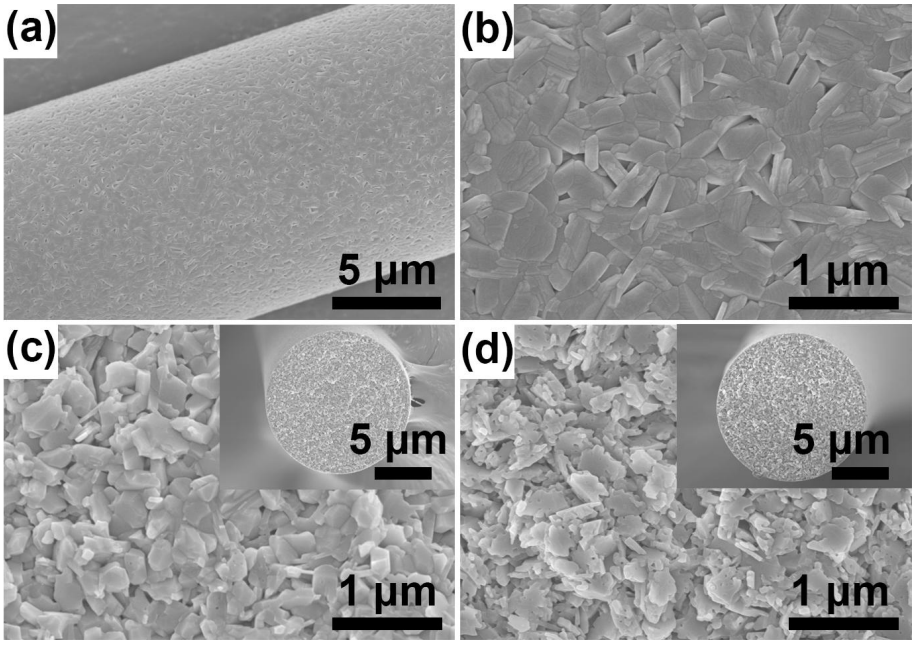
Supplementary Fig. 2 Statistical distribution of grain size of alumina fiber with 0-1 wt.% La_2O_3 held at 1100 ℃ for 0 h, 50 h, 100 h and 200 h, respectively.



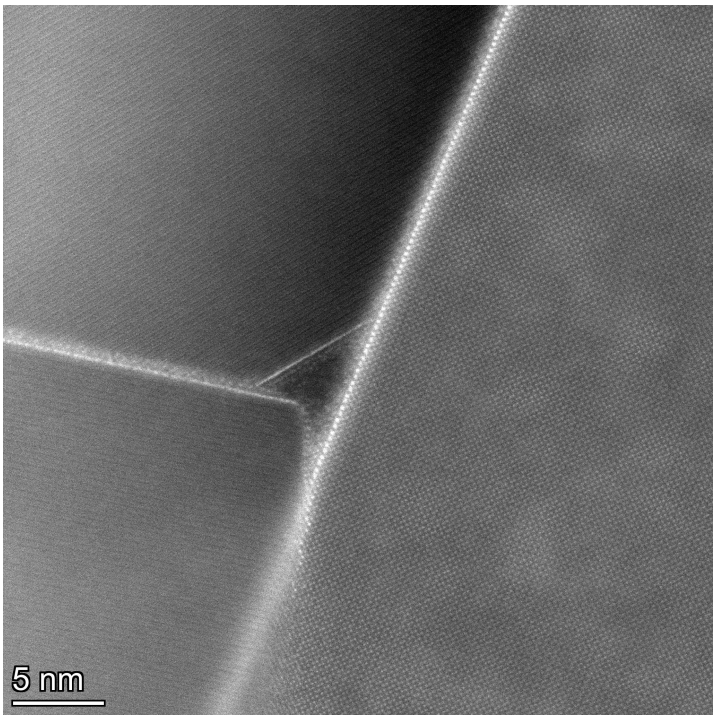
Supplementary Fig. 3 The fracture morphology of alumina fibers with 0.75 wt.% La_2O_3 held at 1300 ℃ for 10 h.



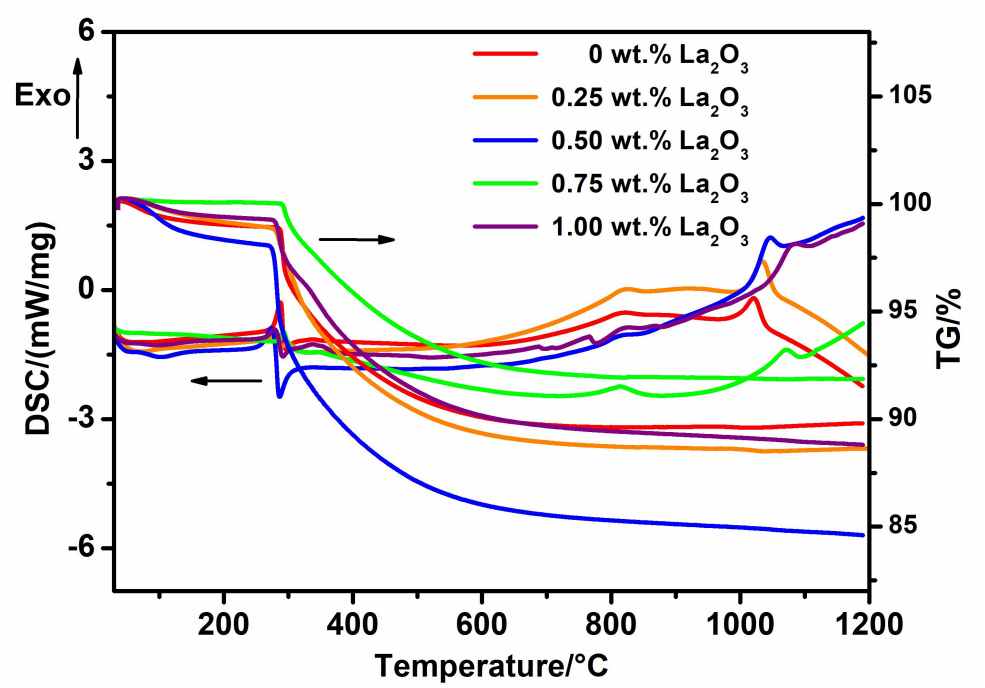
Supplementary Fig. 4 The HAADF-STEM image (a) and elemental mappings (b-e) of alumina fibers with 1 wt.% La_2O_3 sintered at 1500 ℃ for 5 min. The orange frame in (a) is magnified by TEM images (f), and the red frame in (f) is magnified by inverse Fourier transform (IFFT) image (g).



Supplementary Fig. 5 The morphology of continuous alumina fibers with 5 wt.% La_2O_3 after treatment at 1400 ℃ for 10 min (a) the surface, (b) the enlarged area of (a), (c) the enlarged cross section, and after treatment by a two-step sintering (d) the enlarged cross section (Insets in (c) and (d) are the corresponding fracture surface).



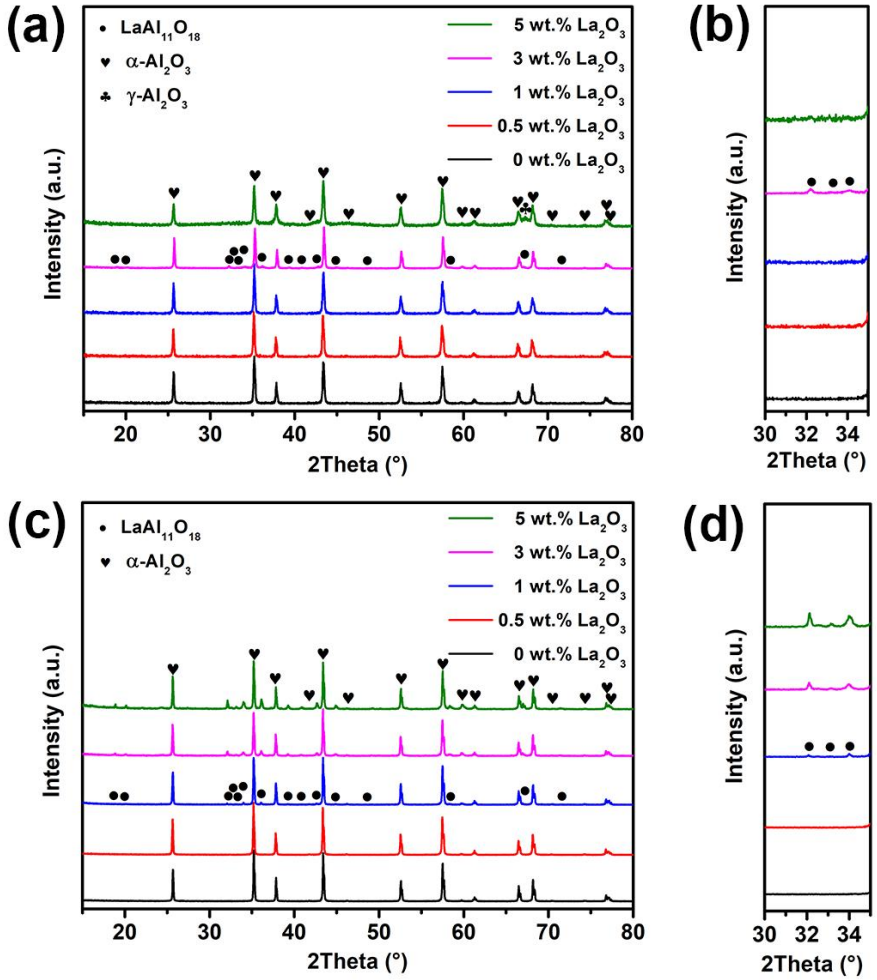
Supplementary Fig. 6 Ordered superstructures at cross grain boundaries after heat treatment at 1100 ℃ for 100 h.



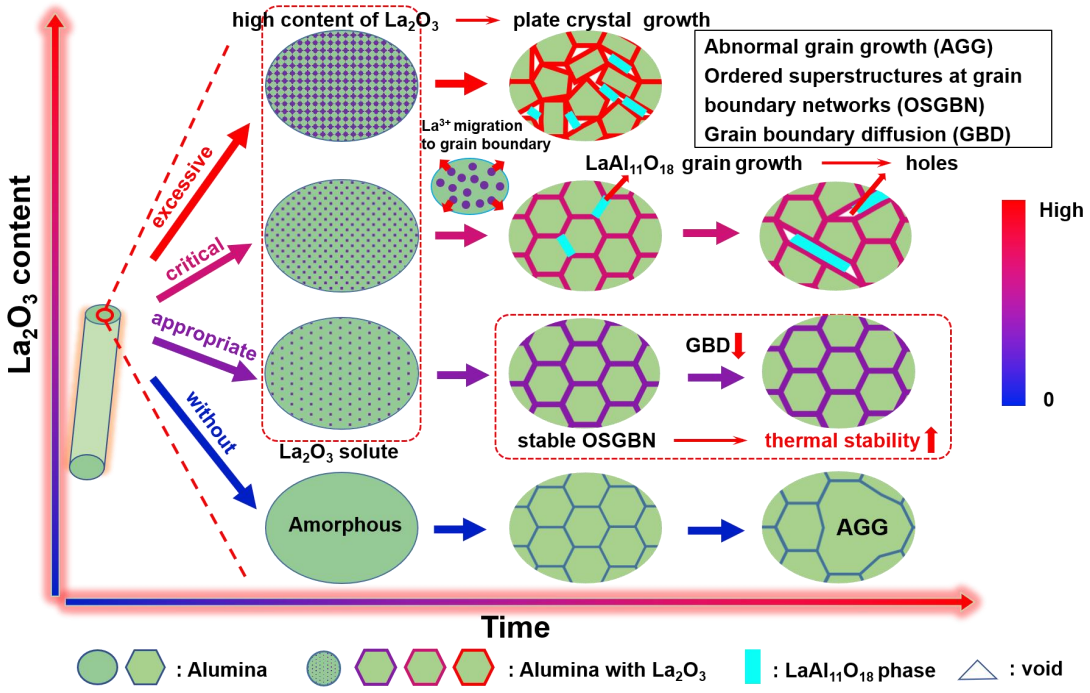
Supplementary Fig. 7 TG/DSC curves of the presintered alumina fiber with different amounts of La_2O_3 from room temperature to 1200 ℃.

Supplementary Table. 1 The phase transformation temperature for the α-Al_2O_3 of presintered alumina fibers with different amounts of La_2O_3.

Amounts of La_2O_3（wt.%）	The phase transition temperature of α-Al_2O_3（℃）
0	1021
0.25	1035
0.5	1046
0.75	1070
1	1082



Supplementary Fig. 8 XRD patterns of the presintered alumina fibers with different amounts of La_2O_3 after heat treatment at different temperatures: (a) 1400 ℃ for 5 min, (b) is an enlarged region of (a), (c) 1400 ℃ for 20 min and (d) is an enlarged region of (c).



Supplementary Fig. 9 Schematic illustration of microstructure evolution of alumina fibers by La_2O_3 addition during the grain growth.