Supplementary Materials

Nanoclay-based 3D aerogel framework for flexible flame retardants

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Movies S1 to S5

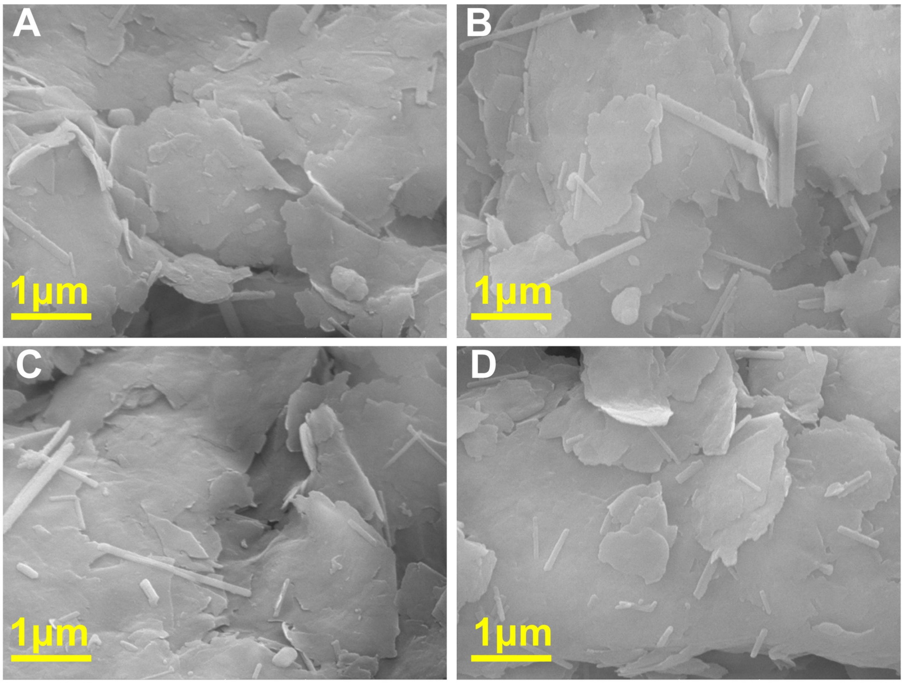

Fig. S1 SEM images of (A) R-RT, (B) R-300, (C) R-450 and (D) R-900.

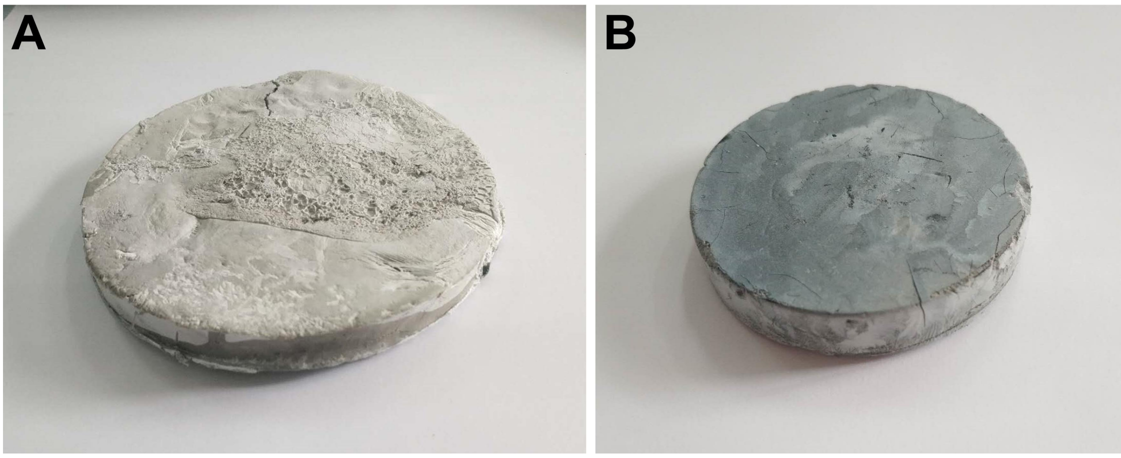

Fig. S2 (A) Aerogel without PA; B Aerogels without synthesized PA in situ

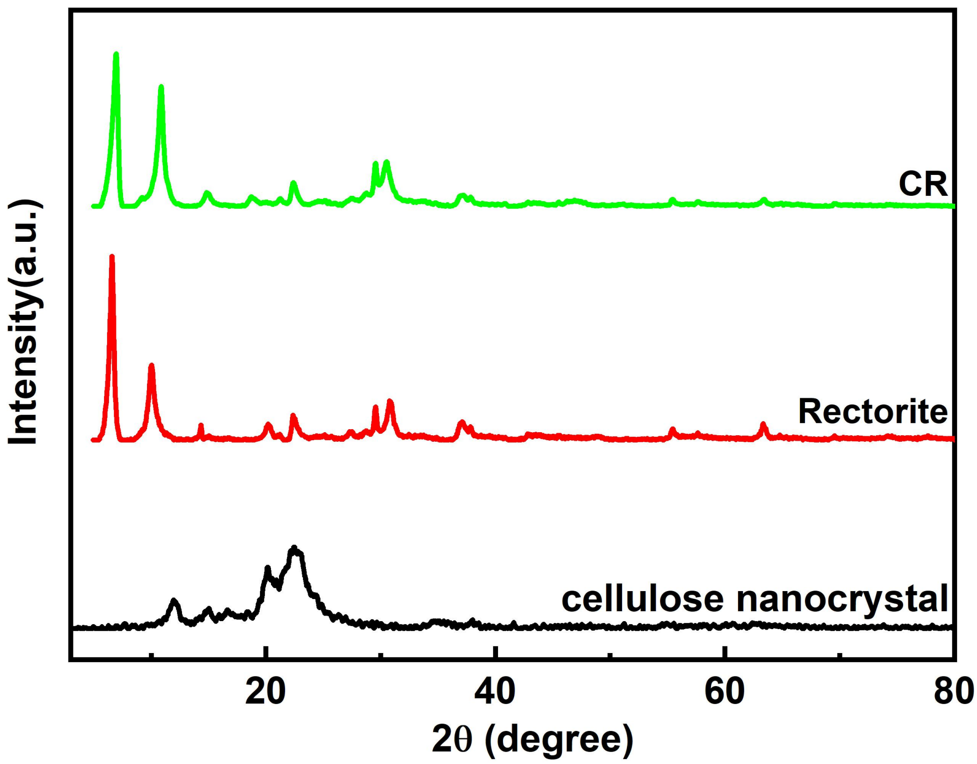

Fig. S3 XRD patterns of cellulose nanocrystal, rectorite and CR.

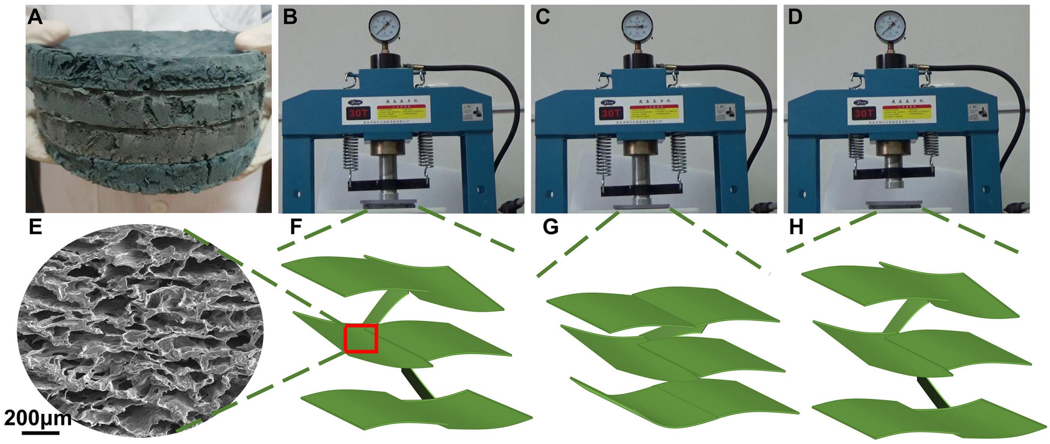

Fig. S4 (A) Photographs of CR/PA/PVA aerogels with a diameter of 14 cm. (B-D) CR/PA/PVA-RT aerogels can support pressure of 10 kN at 80% strain and quickly recover to its original height. (E-H) Schematics of compression and elasticity mechanism of CR/PA/PVA aerogel.

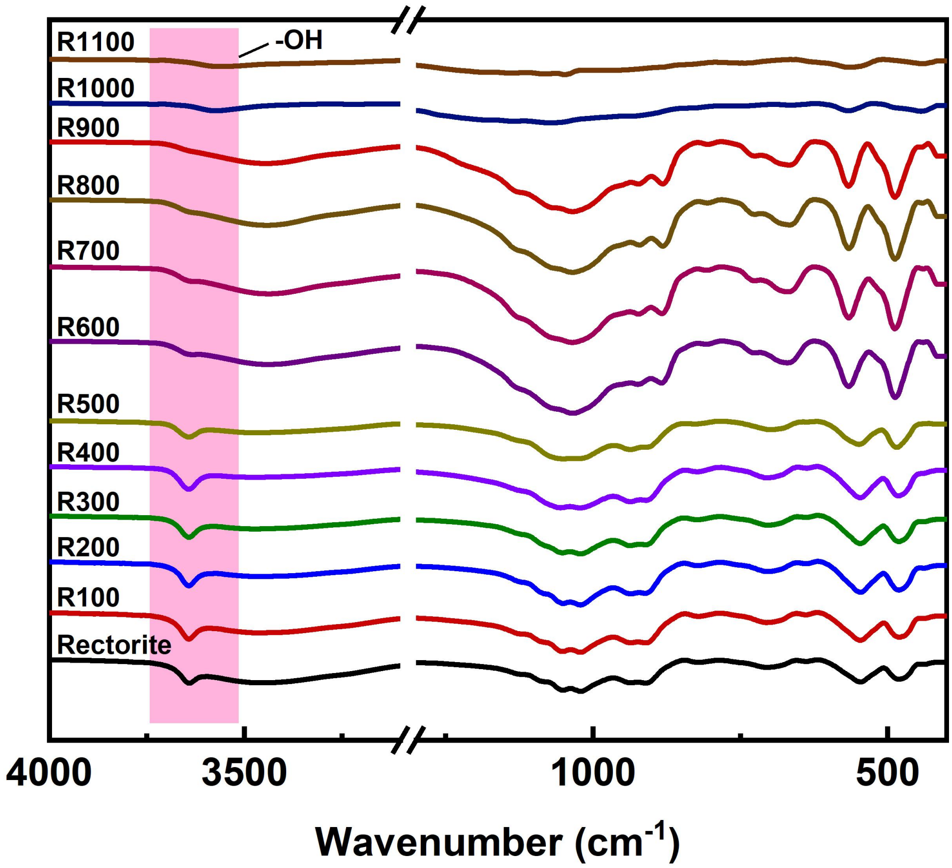

Fig. S5 FTIR spectra of rectorite nanoclay. (R100-R1100 refer to rectorite calcined at 100-1100 °C, respectively. Calcination was performed in a laboratory programmable muffle furnace at a heating rate of 10 °C/min. After being kept at the target temperature for 2 h, it was naturally cooled to RT).

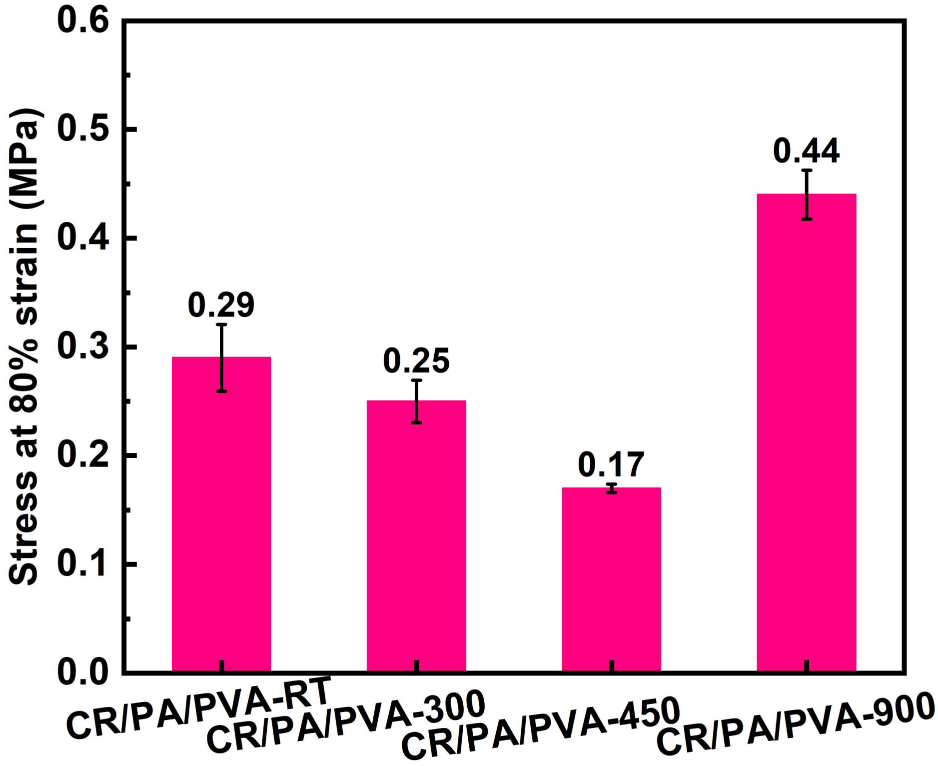

Fig. S6 Value of compressive strength obtained based on Fig. 2h at 80% strain.

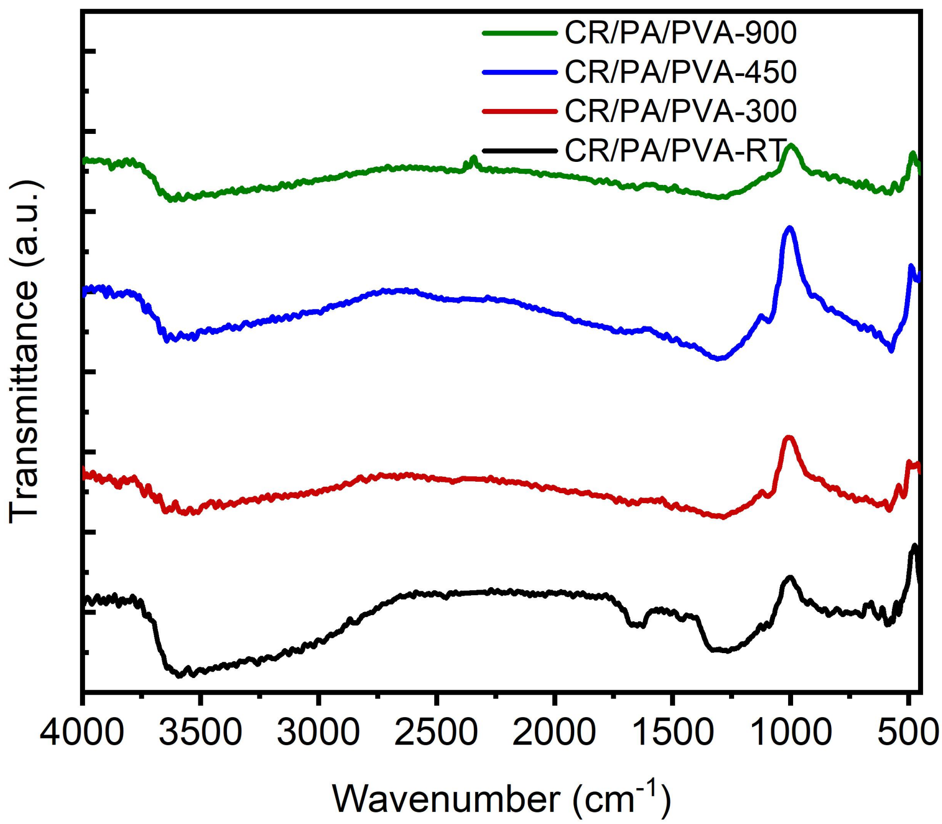

Fig. S7 FTIR spectra of the CR/PA/PVA aerogels.

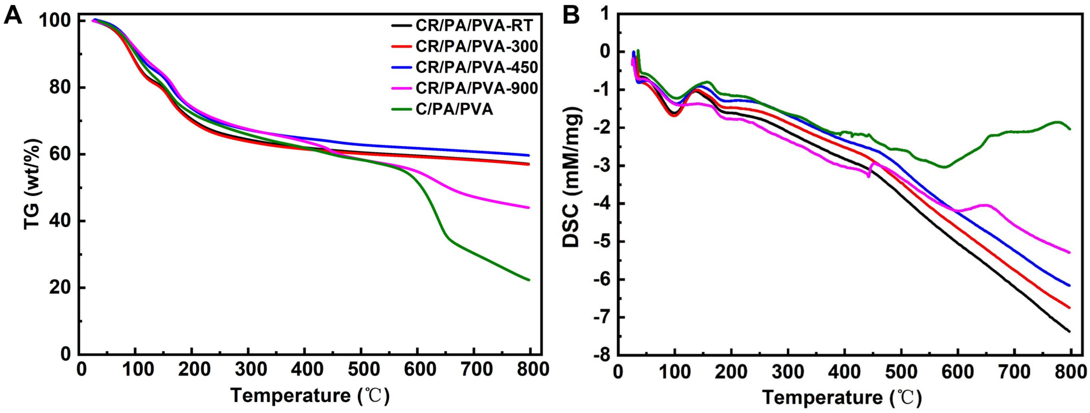

Fig. S8 (A) TGA weight loss and (B) DSC curves of CR/PA/PVA aerogels and control aerogel.

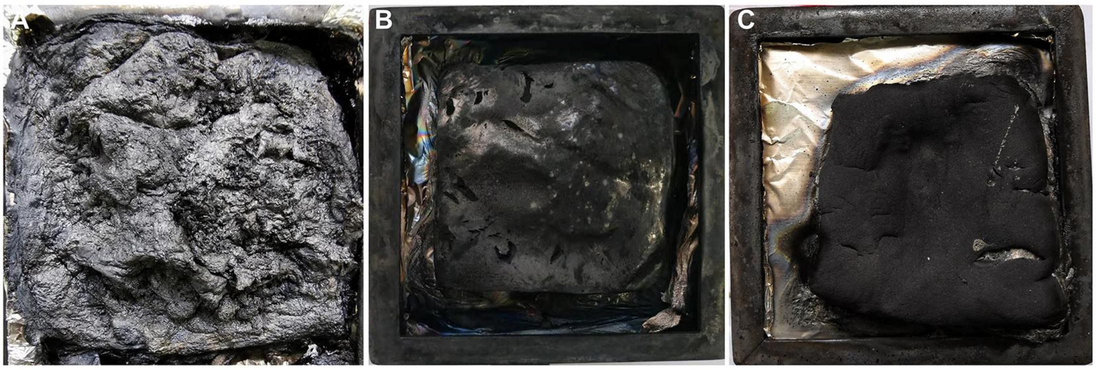

Fig. S9 Photographs of residues after cone calorimeter tests for (A) C/PA/PVA, (B) CR/PA/PVA-RT, and (C) CR/PA/PVA-900.

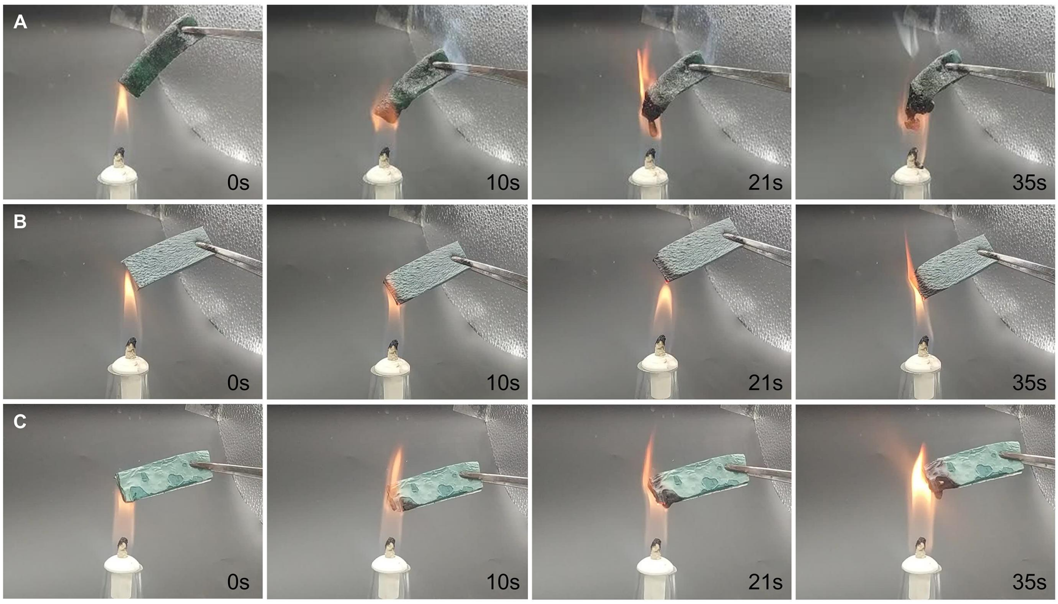

Fig. S10 Photographs of alcohol lamp combustion experiments of (A) C/PA/PVA, (B) CR/PA/PVA-RT, and (C) CR/PA/PVA-900. Magnification corresponding to inset of Fig. 5.

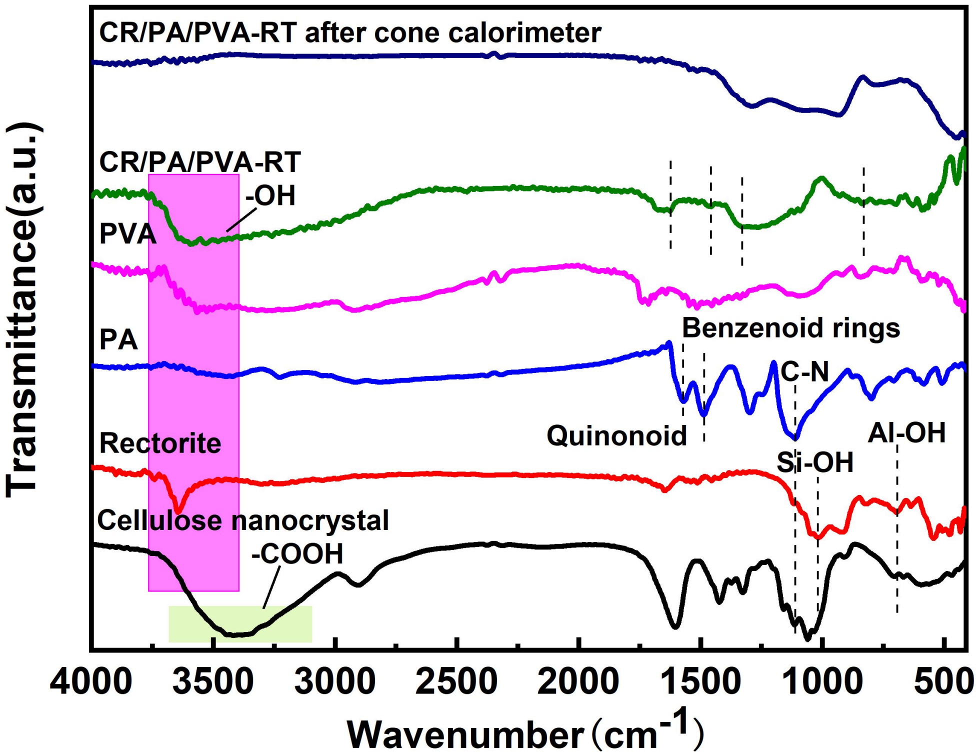

Fig. S11 FTIR spectra of cellulose nanocrystals, rectorite, PA, PVA, CR/PA/PVA-RT aerogel, and CR/PA/PVA-RT aerogels after cone calorimeter tests.

Table S1 Cone calorimeter data of obtained aerogels

Sample	Ignition time (s)	Peak heat-release rate (kW/m^2)	Total heat release (MJ/m^2)	Total smoke release (m^2/m^2)
C/PA/PVA	24	37.1	5.69	522.7
CR/PA/PVA-RT	249	12.9	1.3	72.6
CR/PA/PVA-300	273	14.2	1.4	49.4
CR/PA/PVA-450	No flame	8.3	2.0	77.6
CR/PA/PVA-900	126	13.6	1.2	338.8

Table S2 Comparison of mechanical properties and flame retardancy of CR/PA/PVA aerogels with other clay-based composite aerogels

Sample	Density (g/cm^3)	Ignition time (s)	Peak heat-release rate (kW/m^2)	Reference
PVA/MMT	0.093±0.003	4	140.1	(1)
PVA/MMT/AP	0.115	—	115	(2)
PVA/MMT/AP	0.097±0.001	6	80.4	(3)
PVA/MMT/gelatin	0.108±0.006	3	122	(4)
PVA/SA/MMT/boric acid/CaCl2	0.306±0.012	14±1	82.1	(5)
SA/MMT	0.096±0.002	192	19.3	(6)
SA/MMT	0.098±0.001	215	22.7	(7)
Polyimide/graphene oxide/MMT	0.090±0.002	4	52.5	(8)
Xanthan gum/MMT	0.056±0.001	—	55.2	(9)
SA/MMT	0.11±0	No flame	20	(10)
CR/PA/PVA-RT	0.105	249	12.9	This work
CR/PA/PVA-450	0.998	No flame	8.3	This work

Notes: MMT, montmorillonite; PVA, poly(vinyl alcohol); AP, ammonium polyphosphate; SA, sodium alginate

Table S3 Comparison of mechanical properties and flame retardancy of CR/PA/PVA aerogels with other types of materials

Sample	Ignition time (s)	Peak heat-release rate (kW/m^2)	Compression strength (kPa)	Reference
MFR/pectin	27	80.1	—	(11)
PFR/SiO_2	—	19±1	150	(12)
Cellulose composite	9	58.51	1600	(13)
Co_3O_4-graphene/epoxy resin	—	329	—	(14)
PP/fullerene and carbon nanotubes	—	400±25	—	(15)
CR/PA/PVA-RT	249	12.9	178.8	This work
CR/PA/PVA-450	No flame	8.3	42	This work

Notes: MFR, melamine-formaldehyde resin; PP, polypropylene; PFR, phenol-formaldehyde resin

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Movies S1 to S5

Movie S1. Demonstration of the excellent compression resilience of CR/PA/PVA composite aerogels.

Movie S2. Demonstration that the CR/PA/PVA aerogel with a diameter of 14 cm can withstand a pressure of 10 kN and has good resilience.

Movie S3. Demonstration of the burning process of CR/PA/PVA composite aerogel on a cone calorimeter.

Movie S4. Demonstration of the burning process of C/PA/PVA composite aerogel on a cone calorimeter.

Movie S5. Demonstration of three kinds of aerogels being combusted on an alcohol lamp, including C/PA/PVA, CR/PA/PVA, and CR/PA/PVA-900.