Materials Advances

Supplementary Information for

Influence of pressure-induced structural change in Al_2O_3–SiO_2 glasses on the sound velocity and Poisson's ratio under pressure

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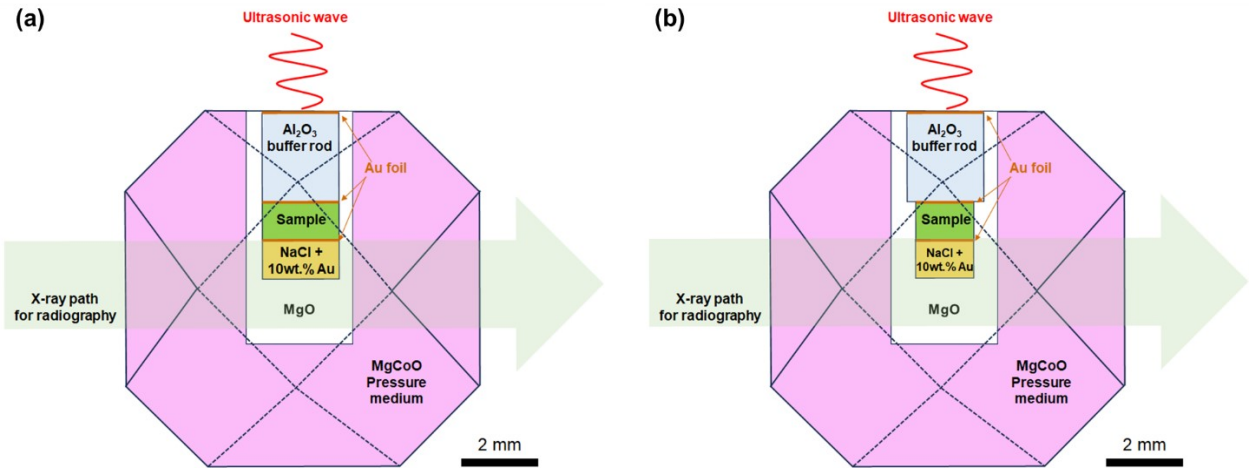

Figure S1. Schematic diagram of the high-pressure cell used in the present ultrasonic experiments. The cell (a) was used for the 29AS, 36AS, 43AS glass samples (initial diameter of sample glass: ~2 mm), while the cell (b) was used for the 50AS and 60AS glasses (initial diameter of sample glass: ~1.5 mm).

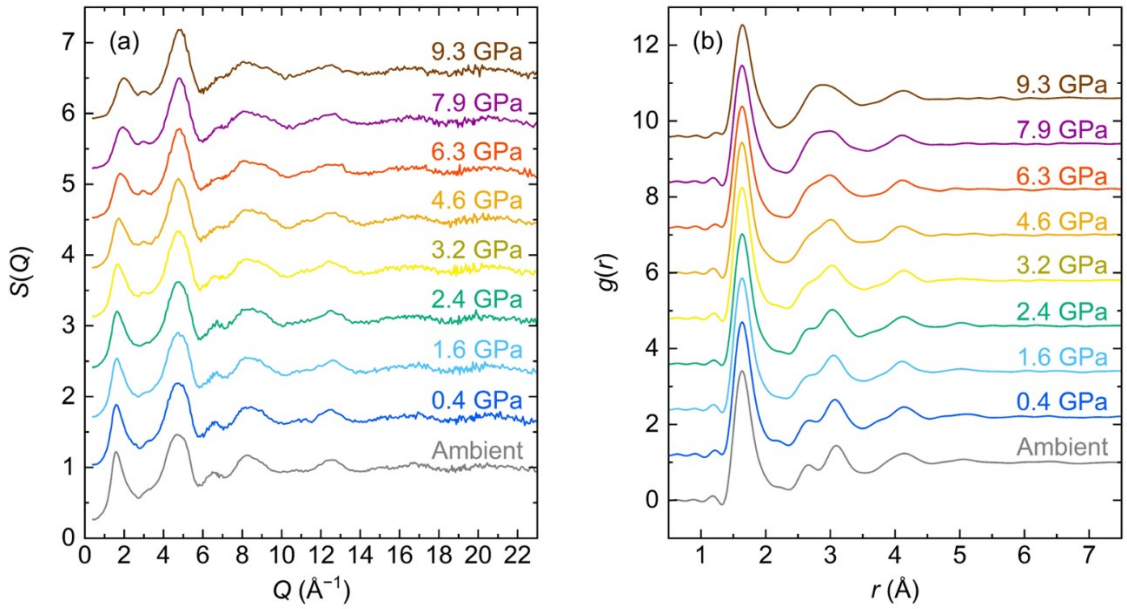

Figure S2. **(a)** Structure factor [$S(Q)$] and **(b)** pair distribution function [$g(r)$] of the 29AS glass obtained by the high-pressure in situ ADXD measurements at BL15XU, SPring-8. The $S(Q)$ and $g(r)$ are displayed by vertical offsets of 0.7 and 1.2, respectively.

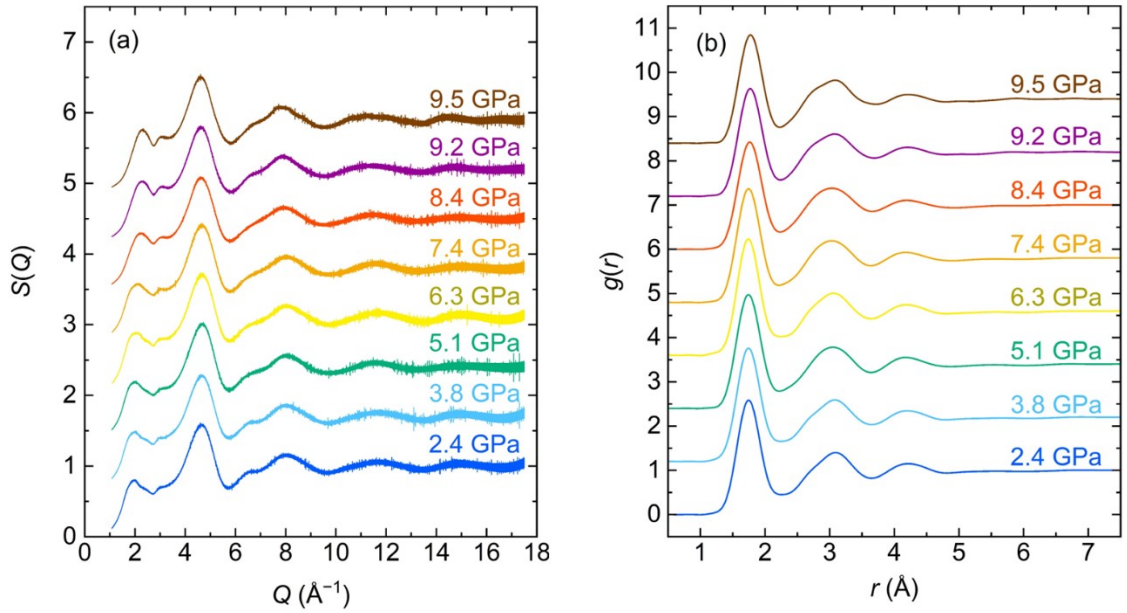

Figure S3. **(a)** Structure factor [$S(Q)$] and **(b)** pair distribution function [$g(r)$] of the 60 AS glass up to 9.5 GPa obtained by the high-pressure *in situ* EDXD measurements at 16-BM-B, APS. The $S(Q)$ and $g(r)$ profiles are displayed by vertical offsets of 0.7 and 1.2, respectively.

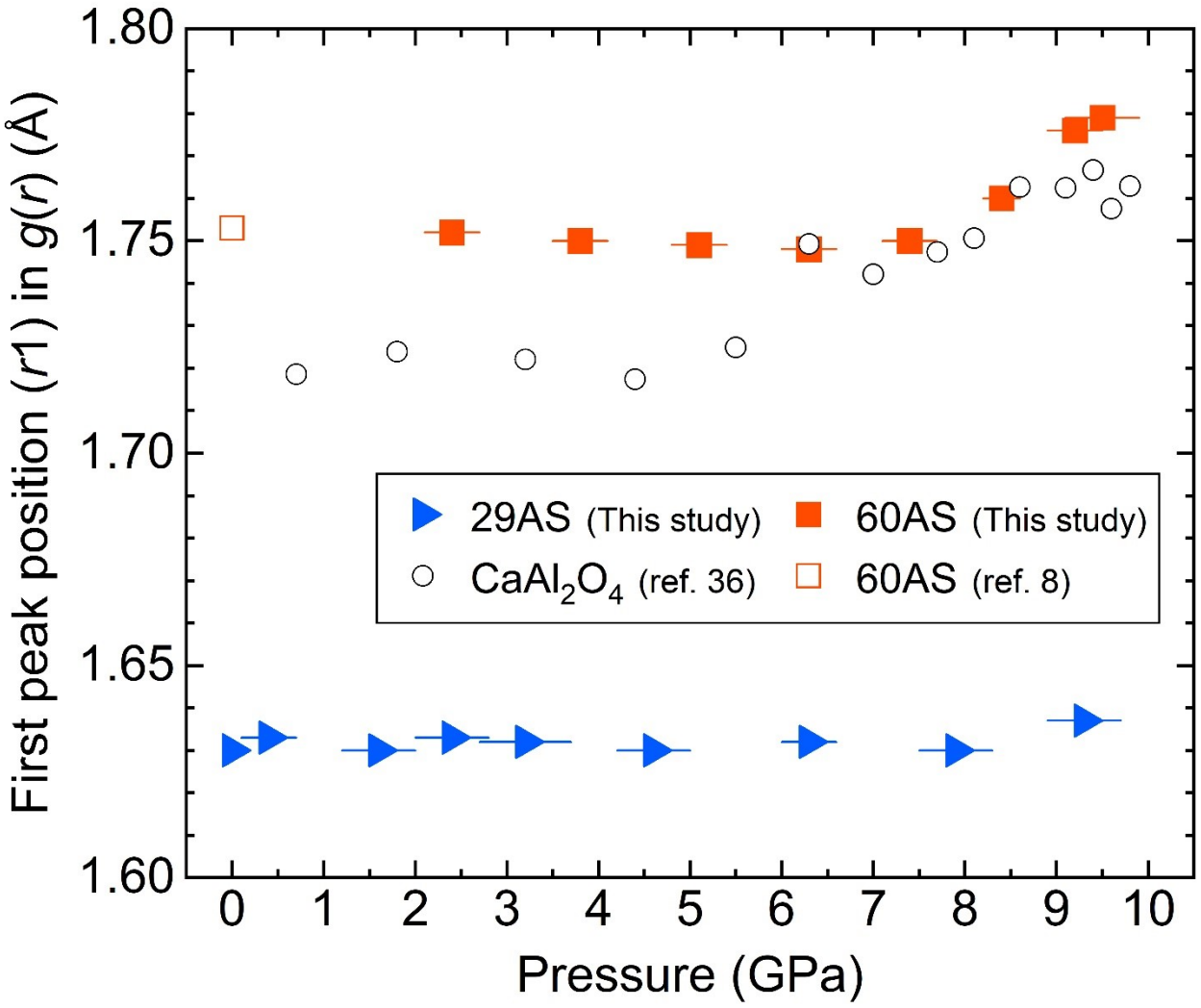

Figure S4. The first peak position ($r1$) in the $g(r)$ of the 29AS, 60AS, and $CaAl_2O_4$[36] glasses at high pressures. The $r1$ was determined from fitting a Gaussian function to the data after subtracting the background using a constant line or a linear function. The fitting ranges are 1.35–1.95 Å for the 29AS glass and 1.35–2.05 Å for the 60AS glass, respectively. Only the $r1$ of the unpressurised 60AS glass (open square) was measured without a high-pressure cell.[8]

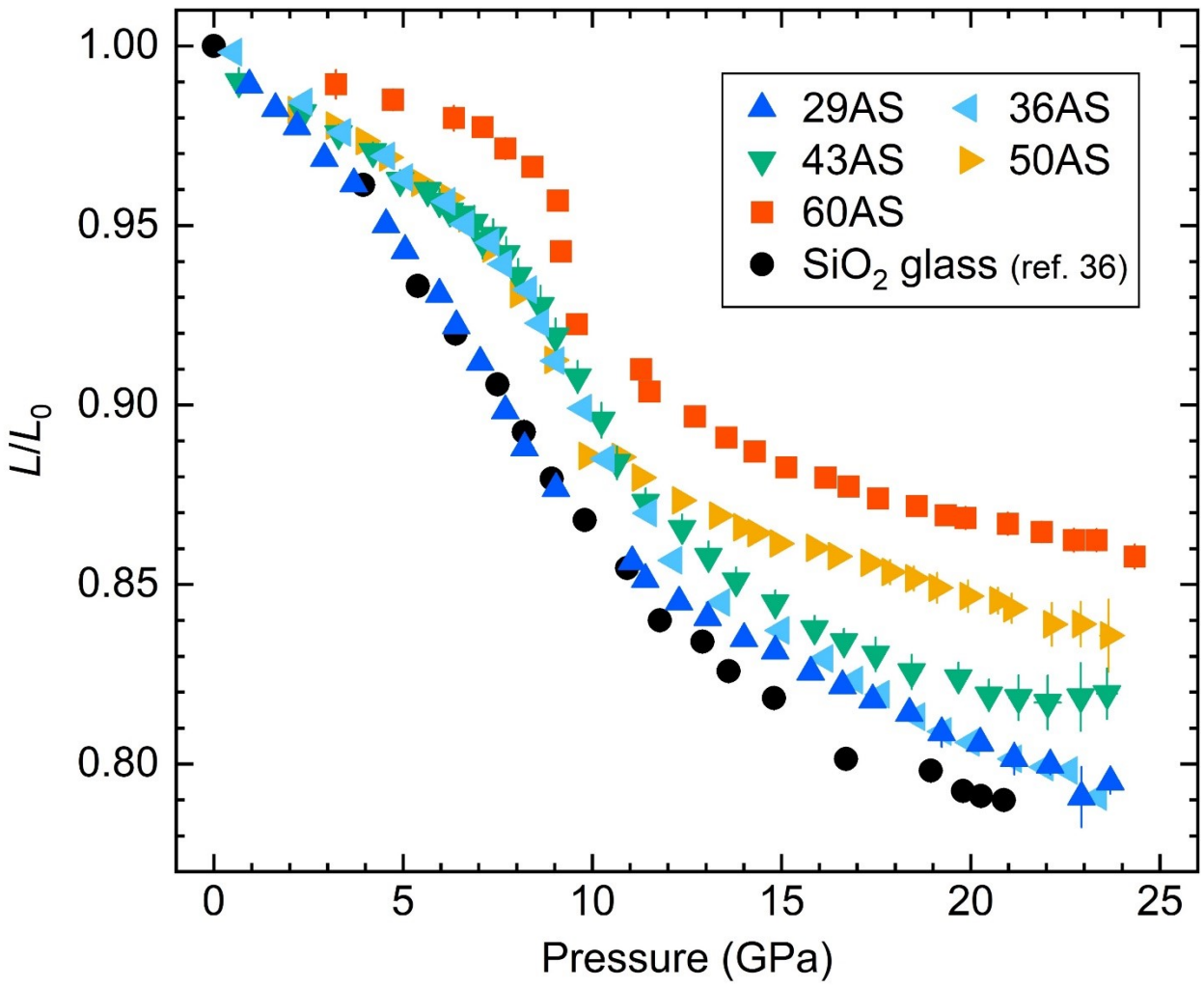

Figure S5. Normalized sample length (L/L_0) of the AS glasses (this study) and SiO_2.[36]

Table S1. Sample length (L), v_L, v_T, and Poisson's ratio (σ) of the 29AS glass.

P (GPa)	L (mm)	v_L (km/s)	v_T (km/s)	σ
0.94(3)	0.989(1)	6.479(8)	3.874(5)	0.222(3)
1.63(8)	0.983(1)	6.335(9)	3.81(4)	0.217(3)
2.20(9)	0.978(1)	6.212(6)	3.755(3)	0.212(2)
2.92(9)	0.969(1)	6.024(6)	3.659(5)	0.208(3)
3.70(12)	0.962(1)	5.877(18)	3.580(5)	0.205(7)
4.55(6)	0.95(1)	5.779(5)	3.508(4)	0.208(3)
5.05(4)	0.943(1)	5.792(6)	3.491(4)	0.215(3)
5.96(4)	0.931(1)	5.881(16)	3.498(5)	0.226(6)
5.96(4)	0.931(1)	5.900(17)	3.507(5)	0.227(7)
6.41(8)	0.922(1)	6.027(9)	3.539(5)	0.237(4)
7.04(9)	0.912(1)	6.212(7)	3.591(4)	0.249(3)
7.70(10)	0.898(1)	6.409(7)	3.651(5)	0.260(3)
8.21(12)	0.888(1)	6.600(9)	3.714(5)	0.268(4)
9.04(12)	0.877(1)	6.843(10)	3.810(11)	0.275(5)
11.05(8)	0.856(1)	7.229(14)	3.947(12)	0.288(5)
11.40(11)	0.851(2)	7.337(17)	3.990(16)	0.290(7)
12.29(6)	0.845(2)	7.509(17)	4.062(13)	0.293(6)
13.05(5)	0.841(2)	7.578(17)	4.079(11)	0.296(6)
14.01(6)	0.835(1)	7.693(11)	4.119(7)	0.299(4)
14.83(4)	0.831(1)	7.808(13)	4.165(10)	0.301(4)
15.77(4)	0.826(2)	7.936(18)	4.215(12)	0.304(6)
16.61(2)	0.822(1)	8.033(15)	4.250(9)	0.306(5)
17.41(2)	0.818(2)	8.156(18)	4.297(10)	0.308(6)
18.38(2)	0.814(1)	8.269(18)	4.339(10)	0.310(6)
19.23(4)	0.809(4)	8.361(43)	4.373(22)	0.312(13)
20.25(10)	0.806(2)	8.507(22)	4.437(14)	0.313(7)
21.15(15)	0.802(4)	8.614(48)	4.480(28)	0.315(14)
22.10(10)	0.800(3)	8.730(29)	4.533(20)	0.315(9)
22.92(16)	0.791(8)	8.760(93)	4.540(49)	0.316(26)
23.69(17)	0.795(3)	8.958(38)	4.640(27)	0.317(11)

*The numbers in parentheses indicate the uncertainties for the last digit. The initial thickness (L_0) is 1.00 mm, and the v_L and v_T at ambient conditions are 6.85 and 4.00 km/s, estimated from the previous measurement.[3]

Table S2. Sample length (L), v_L, v_T, and Poisson's ratio (σ) of the 36AS glass.

P (GPa)	L (mm)	v_L (km/s)	v_T (km/s)	σ
0.52(3)	1.123(1)			
2.38(5)	1.107(1)	6.547(11)	3.859(9)	0.234(5)
3.40(7)	1.098(1)	6.368(11)	3.774(2)	0.229(4)
4.56(9)	1.091(1)	6.234(5)	3.705(2)	0.227(2)
5.04(6)	1.084(1)	6.149(4)	3.655(2)	0.227(1)
6.16(4)	1.076(1)	6.112(4)	3.617(2)	0.230(1)
6.65(6)	1.069(1)	6.106(3)	3.603(2)	0.233(1)
7.32(4)	1.063(1)	6.142(4)	3.605(3)	0.237(2)
7.65(9)	1.057(1)	6.192(3)	3.615(2)	0.241(1)
8.31(6)	1.049(1)	6.276(7)	3.636(3)	0.247(3)
8.63(6)	1.038(1)	6.389(11)	3.670(4)	0.254(4)
9.04(4)	1.026(1)	6.556(14)	3.728(4)	0.261(5)
9.76(2)	1.012(1)	6.777(28)	3.809(5)	0.269(10)
10.36(4)	0.996(1)	6.984(29)	3.891(8)	0.275(10)
11.48(3)	0.979(1)	7.256(41)	3.997(7)	0.282(13)
12.15(4)	0.964(1)	7.462(33)	4.081(3)	0.287(10)
13.42(6)	0.951(1)	7.68(43)	4.158(9)	0.293(13)
14.98(2)	0.942(1)	7.859(41)	4.225(10)	0.297(12)
16.14(3)	0.933(1)	8.040(38)	4.293(9)	0.301(11)
16.93(4)	0.926(1)	8.120(41)	4.312(8)	0.304(11)
17.63(2)	0.922(1)	8.247(28)	4.365(6)	0.305(8)
18.57(2)	0.915(1)	8.369(33)	4.407(6)	0.308(9)
19.27(6)	0.910(2)	8.458(31)	4.438(8)	0.310(8)
20.01(10)	0.907(2)	8.550(26)	4.470(11)	0.312(7)
21.13(10)	0.902(2)	8.677(27)	4.513(9)	0.315(7)
21.96(15)	0.899(2)	8.752(33)	4.536(12)	0.316(9)
22.60(9)	0.898(2)	8.862(34)	4.580(12)	0.318(9)
23.37(14)	0.890(3)	8.910(36)	4.593(14)	0.319(9)

*The numbers in parentheses indicate the uncertainties for the last digit. The initial thickness (L_0) is 1.13 mm, and the v_L and v_T at ambient conditions are 7.00 and 4.05 km/s, estimated from the previous measurement.[3]

Table S3. Sample length (L), v_L, v_T, and Poisson's ratio (σ) of the 43AS glass.

P (GPa)	L (mm)	v_L (km/s)	v_T (km/s)	σ
0.66(3)	0.921(4)	7.039(27)	4.047(16)	0.253(10)
2.35(4)	0.913(3)	6.836(23)	3.962(14)	0.247(9)
3.30(8)	0.907(2)	6.706(17)	3.890(10)	0.246(7)
4.20(9)	0.903(2)	6.621(17)	3.840(10)	0.246(7)
4.92(8)	0.895(3)	6.533(20)	3.783(12)	0.248(8)
5.65(13)	0.893(2)	6.511(18)	3.761(11)	0.250(7)
5.96(13)	0.890(3)	6.492(24)	3.750(14)	0.250(9)
6.24(13)	0.887(3)	6.487(21)	3.744(13)	0.250(9)
6.54(10)	0.886(3)	6.495(21)	3.746(12)	0.251(8)
6.88(17)	0.884(4)	6.502(32)	3.741(18)	0.253(13)
7.10(16)	0.880(5)	6.491(34)	3.731(20)	0.253(14)
7.38(14)	0.881(4)	6.537(32)	3.747(18)	0.255(13)
7.73(14)	0.876(4)	6.557(34)	3.748(19)	0.257(13)
8.04(12)	0.870(4)	6.607(34)	3.757(19)	0.261(13)
8.63(11)	0.863(5)	6.711(40)	3.789(23)	0.266(15)
9.03(11)	0.855(5)	6.818(37)	3.823(21)	0.271(14)
9.61(5)	0.844(4)	7.011(35)	3.893(20)	0.277(13)
10.24(11)	0.833(5)	7.196(40)	3.960(22)	0.283(14)
10.65(9)	0.822(4)	7.37(39)	4.030(22)	0.287(13)
11.41(7)	0.812(4)	7.558(35)	4.106(20)	0.291(12)
12.37(8)	0.805(4)	7.722(36)	4.174(19)	0.294(11)
13.07(9)	0.798(4)	7.871(39)	4.232(21)	0.297(12)
13.80(10)	0.791(4)	7.990(36)	4.278(20)	0.299(11)
14.83(7)	0.786(3)	8.140(35)	4.337(19)	0.302(11)
15.87(10)	0.779(3)	8.248(36)	4.377(19)	0.304(11)
16.65(11)	0.776(3)	8.383(37)	4.437(20)	0.305(11)
17.49(16)	0.772(4)	8.502(49)	4.483(26)	0.308(14)
18.44(13)	0.768(4)	8.684(51)	4.562(27)	0.309(14)
19.67(22)	0.766(4)	8.784(46)	4.599(24)	0.311(13)
20.48(20)	0.762(4)	8.841(48)	4.617(25)	0.313(13)
21.26(25)	0.761(6)	8.95(69)	4.663(36)	0.314(19)
22.03(35)	0.760(7)	9.044(84)	4.704(43)	0.315(23)

22.90(24)	0.761(9)	9.181(106)	4.769(55)	0.315(28)
23.60(27)	0.762(7)	9.288(80)	4.819(42)	0.316(21)

*The numbers in parentheses indicate the uncertainties for the last digit. The initial thickness (L_0) is 0.93 mm, and the v_L and v_T at ambient conditions are 7.20 and 4.15 km/s, estimated from the previous measurement.[3]

Table S4. Sample length (L), v_L, v_T, and Poisson's ratio (σ) of the 50AS glass.

P (GPa)	L (mm)	v_L (km/s)	v_T (km/s)	σ
2.18(8)	0.825(2)	7.060(15)	4.013(11)	0.261(6)
3.18(8)	0.821(2)	6.979(15)	3.960(11)	0.263(6)
3.98(6)	0.818(1)	6.910(15)	3.914(14)	0.264(6)
4.59(4)	0.814(1)	6.855(11)	3.874(13)	0.265(5)
5.44(2)	0.808(1)	6.781(14)	3.823(7)	0.267(5)
6.21(2)	0.804(1)	6.773(12)	3.811(11)	0.268(5)
6.68(3)	0.800(2)	6.810(13)	3.810(8)	0.272(5)
7.32(7)	0.793(2)	6.924(15)	3.857(13)	0.275(6)
8.05(6)	0.782(2)	7.150(16)	3.931(9)	0.283(6)
8.96(11)	0.767(1)	7.460(16)	4.053(11)	0.291(6)
9.86(10)	0.744(2)	7.648(19)	4.127(15)	0.295(7)
10.74(9)	0.744(2)	7.939(19)	4.253(11)	0.299(6)
11.27(14)	0.739(2)	8.082(18)	4.318(10)	0.300(6)
12.33(6)	0.734(2)	8.196(19)	4.361(12)	0.302(6)
13.31(5)	0.730(2)	8.282(19)	4.401(19)	0.303(7)
13.95(6)	0.727(2)	8.357(23)	4.435(15)	0.304(7)
14.32(4)	0.726(2)	8.419(29)	4.460(12)	0.305(8)
14.91(4)	0.724(2)	8.483(25)	4.481(14)	0.306(7)
15.87(3)	0.723(2)	8.559(26)	4.511(14)	0.308(8)
16.45(6)	0.721(2)	8.645(26)	4.537(13)	0.310(7)
17.31(7)	0.719(2)	8.710(26)	4.563(13)	0.311(7)
17.87(9)	0.717(3)	8.774(35)	4.597(19)	0.311(10)
18.49(7)	0.715(3)	8.858(39)	4.631(21)	0.312(11)
19.11(10)	0.713(4)	8.908(45)	4.657(23)	0.312(12)
19.93(10)	0.711(4)	8.998(49)	4.687(25)	0.314(13)
20.72(12)	0.710(3)	9.098(60)	4.719(28)	0.316(16)
21.08(13)	0.708(3)	9.177(64)	4.754(26)	0.317(16)
22.14(11)	0.705(5)	9.232(75)	4.779(36)	0.317(20)
22.90(17)	0.705(5)	9.337(73)	4.827(37)	0.318(19)
23.64(23)	0.702(8)	9.429(118)	4.854(59)	0.320(30)

*The numbers in parentheses indicate the uncertainties for the last digit. The initial thickness (L_0) is 0.84 mm, and the v_L and v_T at ambient conditions are 7.41 and 4.22 km/s, estimated from the previous measurement.[3]

Table S5. Sample length (L), v_L, v_T, and Poisson's ratio (σ) of the 60AS glass.

P (GPa)	L (mm)	v_L (km/s)	v_T (km/s)	σ
3.22(5)	0.719(3)	7.496(18)	4.118(17)	0.284(7)
4.73(6)	0.716(2)	7.446(14)	4.072(12)	0.287(5)
6.34(2)	0.719(3)	7.363(19)	4.012(15)	0.289(7)
7.10(5)	0.719(3)	7.335(14)	3.992(12)	0.290(5)
7.70(5)	0.706(2)	7.306(13)	3.973(16)	0.290(6)
8.42(2)	0.703(2)	7.356(11)	3.999(15)	0.290(5)
9.09(2)	0.696(2)	7.496(12)	4.048(12)	0.294(5)
9.17(7)	0.685(2)	7.752(12)	4.164(13)	0.297(5)
9.59(8)	0.671(2)	8.115(18)	4.309(13)	0.304(6)
11.29(5)	0.662(2)	8.364(15)	4.423(13)	0.306(5)
11.51(6)	0.657(2)	8.504(13)	4.478(13)	0.308(4)
12.71(8)	0.652(2)	8.66(19)	4.532(14)	0.311(6)
13.54(5)	0.648(2)	8.754(18)	4.568(14)	0.313(6)
14.29(2)	0.645(2)	8.867(13)	4.624(16)	0.313(5)
15.12(2)	0.642(2)	8.946(13)	4.656(14)	0.314(4)
16.16(5)	0.640(2)	9.020(14)	4.688(15)	0.315(5)
16.77(9)	0.638(2)	9.095(14)	4.719(14)	0.316(4)
17.55(11)	0.635(2)	9.173(12)	4.749(15)	0.317(4)
18.57(14)	0.634(2)	9.279(13)	4.797(13)	0.318(4)
19.34(11)	0.632(2)	9.333(15)	4.817(16)	0.318(5)
19.86(7)	0.631(2)	9.424(19)	4.858(18)	0.319(6)
20.98(15)	0.630(2)	9.492(22)	4.888(20)	0.320(7)
21.87(7)	0.629(2)	9.556(26)	4.914(19)	0.320(7)
22.72(21)	0.627(2)	9.622(29)	4.945(21)	0.321(8)
23.32(15)	0.627(2)	9.707(28)	4.984(19)	0.321(7)
24.33(20)	0.624(2)	9.709(27)	4.982(21)	0.321(7)

*The numbers in parentheses indicate the uncertainties for the last digit. The initial thickness (L_0) is 0.73 mm, and the v_L and v_T at ambient conditions are 7.71 and 4.30 km/s, estimated from the previous measurement.[3]

Table S6. Chemical compositions of each domain shown in Figure 1.

mol%	60AS	50AS		43AS		36AS		29AS	
		Si-rich	Al-rich	Si-rich	Al-rich	Si-rich	Al-rich	Dark	Bright
SiO_2	39.2(6)	64.8(14)	37.1(17)	72.7(11)	43.8(11)	74.2(9)	56.8(10)	75.1(7)	74.3(6)
Al_2O_3	60.8(6)	35.2(14)	62.9(17)	27.3(11)	56.2(11)	25.8(9)	43.8(10)	24.9(7)	25.7(6)

*The numbers in parentheses indicate the uncertainties for the last digit.

Table S7. Pressure dependence of the five AS glasses obtained from linear fitting on the vecloity–pressure plots between 12–23 GPa.

	dv_L/dP	dv_T/dP
	(km/s/GPa)	
29AS	0.1279(13)	0.0496(9)
36AS	0.1299(25)	0.0482(9)
43AS	0.1366(33)	0.0551(13)
50AS	0.1077(13)	0.0429(7)
60AS	0.0987(20)	0.0416(9)

*The numbers in parentheses indicate the uncertainties for the last digit.