Electronic Supplementary Information

to the manuscript:

Conformational plasticity of DNA secondary structures: probing the conversion between i-motif and hairpin species by circular dichroism and ultraviolet resonance Raman spectroscopies

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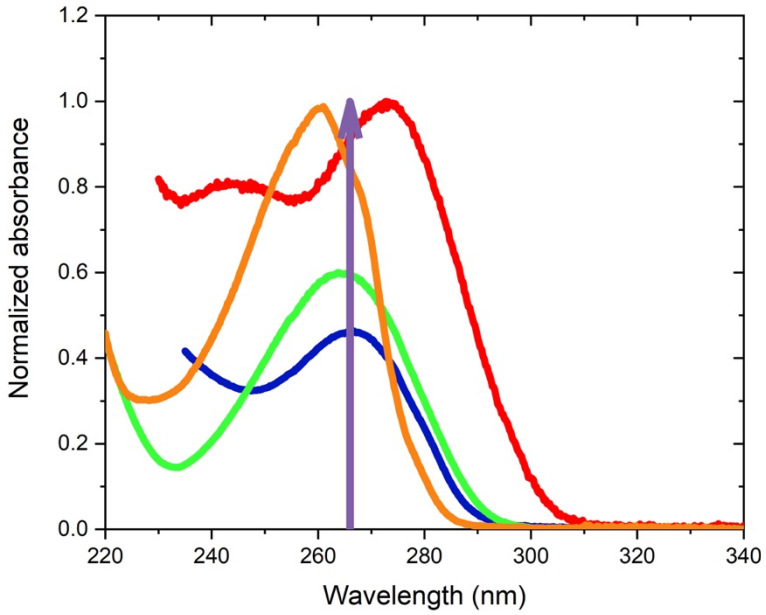

Fig. S1 UV-VIS absorbance of water solutions of DNA nucleobases (guanine: red; cytosine: blue; adenine: orange; thymine: green).[1,2] The purple arrow indicates the excitation wavelength (266 nm) used in the experiment. The absorbance of the higher absorption peak is set to 1.

1 M. Taniguchi, H. Du and J. S. Lindsey, PhotochemCAD 3: Diverse Modules for Photophysical Calculations with Multiple Spectral Databases, *Photochem. Photobiol.*, 2018, **94**, 277–289.

2 M. Taniguchi and J. S. Lindsey, Database of Absorption and Fluorescence Spectra of >300 Common Compounds for use in PhotochemCAD, *Photochem. Photobiol.*, 2018, **94**, 290–327.

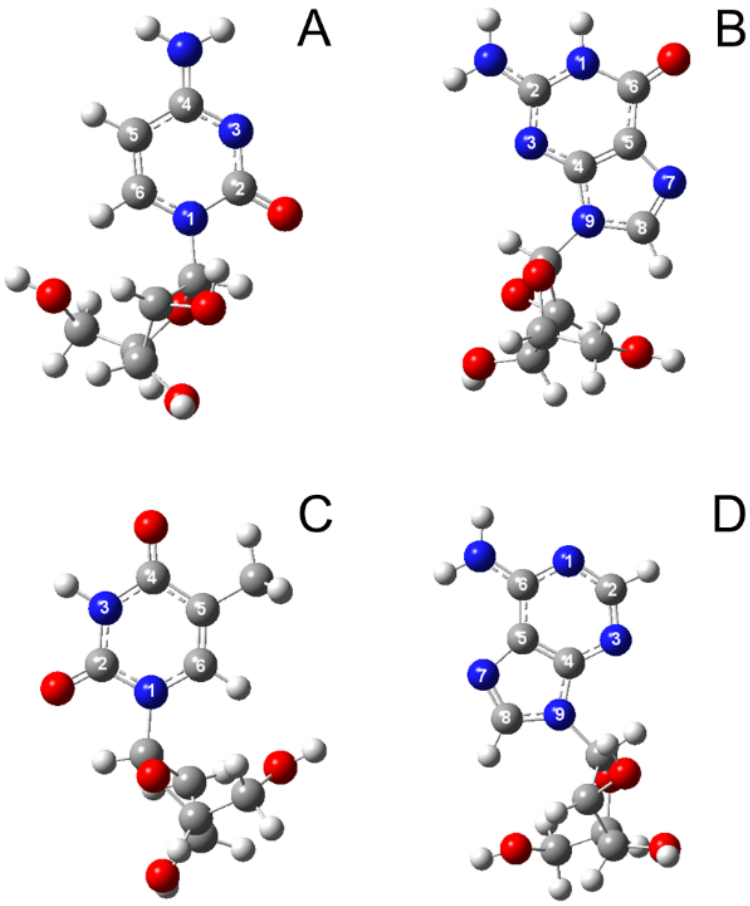

Fig. S2 Structures and numbering convention for DNA nucleobases (A) cytosine, (B) guanine, (C) thymine, and (D) adenine.

Table S1. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *BCL2* at pH 7.8.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), bk	**a**	781.9	±0.2	69.3	±2.3	1110	±66	15.0	±0.6
bk [O-P-O]		806.3	±2.6	18.6	±1.2	1151	±112	58	±5
bk		991.9	±0.6	23.9	±1.7	466	±45	18.3	±1.6
$P(OH)O_2^-$		1062	±5	9.9	±0.7	1505	±172	143	±15
dC, dG, dT		1203.6	±2.0	36.1	±1.1	2043	±179	53	±4
dT (C5-CH_3, ring s)	**b**	1237.0	±0.4	84	±34	1204	±662	13.5	±2.0
dC (C6H b, C4N s); dA (N1C2, C8N9 s; C2H b)	**c**	1251.7	±2.3	95	±8	2581	±1150	25	±10
dC	**d**	1270.2	±0.9	57	±20	884	±408	14.6	±1.8
dC (N1C6, C5C6 s)	**e**	1295.4	±0.1	123.1	±1.8	2098	±36	16.0	±0.3
dG (N7C8 s; C8H b); dA (C5N7, N7C8 s)		1336.7	±0.7	12.5	±2.8	83	±19	6.2	±1.6
dT (C5-CH_3 s); dA	**f**	1374.2	±0.2	95.3	±1.6	1988	±36	19.6	±0.4
d, dG (C4N9, C5N7 s)		1417.1	±1.3	11.6	±1.6	241	±36	20	±3
d		1464.7	±1.2	9.3	±2.4	88	±30	8.9	±2.9
dG (C8H b; C8N9, N7C8 s); dA (C4N9 s, C8H b)	**g**	1487.5	±0.2	138.5	±1.7	3104	±86	21.1	±0.6
dA		1509.2	±1.0	28.2	±2.8	447	±115	14.9	±2.9
dC (N3C4 and N1C2 s)	**h**	1529.1	±0.2	161.8	±1.7	3335	±80	19.4	±0.5
dG (C4=C5, N3C4 and C5N7 s), dA (C4C5, N3C4 s)	**i**	1577.2	±0.3	55.8	±1.7	1013	±37	17.1	±0.7
dG exocyclic NH_2 scissors, dC (C=O s) (paired)	**j**	1622.3	±2.3	32	±3	1480	±147	43.3	-
dC, dT (C=O s) (unpaired)	**k**	1653.4	±0.4	131.0	±2.7	4738	±204	34.0	±0.9
dG (C=O s) (unpaired)	**l**	1679	-	32.0	±2.1	1477	±95	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S2. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *BCL2* at pH 6.6.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), C^+, $C{\cdot}C^+$, bk	**a**	785.9	±0.1	119.9	±1.3	2147	±26	16.8	±0.2
bk [O-P-O]		855.3	±1.8	8.5	±1.0	287	±37	32	±4
bk		998.0	±0.9	18.0	±0.9	676	±40	35.2	±2.2
$P(OH)O_2^-$		1085.1	±1.7	7.2	±1.2	153	±28	20	±4
dC, C^+, $C{\cdot}C^+$, dG, dT		1196.8	±1.3	32.3	±0.7	2394	±97	70	±3
dT (C5-CH_3, ring s)	**b**	1240.7	±0.3	100	±10	2010	±298	18.9	±0.9
dC, C^+, $C{\cdot}C^+$	**d**	1263.0	±0.8	160.4	1.9	6000	±375	35.1	±1.9
dC (N1C6, C5C6 s)	**e**	1295.2	±0.1	126.6	±2.7	2054	±74	15.2	±0.3
dG (N7C8 s; C8H b); dA (C5N7, N7C8 s)		1334.8	±0.7	10.9	±1.8	104	±18	9.0	±1.8
dT (C5-CH_3 s); dA	**f**	1376.7	±0.2	132.7	±1.3	2971	±48	21.0	±0.4
dC, C^+, $C{\cdot}C^+$	**f'**	1394.9	±0.9	13.1	±2.2	146	±42	10.4	±2.3
d, dG (C4N9, C5N7 s)		1419.0	±0.7	20.3	±1.3	448	±32	20.8	±1.7
d		1467.4	±1.1	8.8	±2.1	84	±29	8.9	±2.7
dG (C8H b; C8N9, N7C8 s); dA (C4N9 s, C8H b)	**g**	1486.6	±0.1	154.7	±1.4	3310	±61	20.1	±0.4
dA		1507.9	±1.7	13	-	193	±54	13	±4
dC (N3C4 and N1C2 s)	**h**	1529.1	-	110.6	±1.5	2361	±85	20.0	±0.8
dC, C^+, $C{\cdot}C^+$	**h'**	1543.3	-	41	±3	677	±49	15.6	±0.8
dG (C4=C5, N3C4 and C5N7 s), dA (C4C5, N3C4 s)	**i**	1577.2	±0.2	45.6	±1.4	732	±24	15.1	±0.6
dG exocyclic NH_2 scissors, dC (C=O s)	**j**	1619.8	±1.5	23.9	±2.3	851	±82	33.3	-
dT, dC (C=O s) (unpaired)	**k**	1652.8	±0.2	181.2	±1.2	6934	±134	36.0	±0.6
dG (C=O s) (unpaired)	**l**	1679	-	52.4	±1.8	2414	±81	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S3. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *BCL2* at pH 5.2.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), C^+, $C{\cdot}C^+$, bk	**a**	785.1	±0.1	137.2	±1.8	2336	±52	16.00	±0.25
bk [O-P-O]		804.7	±1.7	21.1	±1.1	1271	±81	56.7	±2.7
bk		1008.4	±1.5	11.7	±0.9	454	±42	37	±4
$P(OH)O_2^-$		1075.7	±2.4	8.2	±0.8	422	±50	48	±6
dC, C^+, $C{\cdot}C^+$, dG, dT		1188.5	±1.1	29.0	±0.7	2296	±84	74	±3
dT (C5-CH_3, ring s)	**b**	1240.4	±0.4	93	±11	1927	±317	19.4	±1.0
dC, C^+, $C{\cdot}C^+$	**d**	1262.8	±0.6	191.9	±1.8	6926	±393	33.9	±1.7
dC (N1C6, C5C6 s)	**e**	1292.9	±0.2	89	±3	1409	±84	14.9	±0.5
dG (N7C8 s; C8H b); dA (C5N7, N7C8 s)		1332.4	±1.7	9.2	±1.0	305	±40	31	±5
dT (C5-CH_3 s); dA	**f**	1375.7	±0.2	117.3	±1.2	2781	±65	22.3	±0.6
dC, C^+, $C{\cdot}C^+$	**f'**	1392.9	±0.5	25.5	±2.9	284	±58	10.5	±1.3
d, dG (C4N9, C5N7 s)		1416.1	±0.9	18.6	±1.1	496	±39	25.1	±2.3
dG (C8H b; C8N9, N7C8 s); dA (C4N9 s, C8H b)	**g**	1484.1	±0.2	103.1	±1.3	2004	±49	18.3	±0.4
dA		1504.9	±2.6	13.1	±1.5	279	±32	20	-
dC (N3C4 and N1C2 s)	**h**	1529.1	-	68.2	±1.9	1408	±76	19.4	±1.1
dC, C^+, $C{\cdot}C^+$	**h'**	1543.3	±0.2	77.0	±2.9	1298	±46	15.8	±0.4
dG (C4=C5, N3C4 and C5N7 s), dA (C4C5, N3C4 s)	**i**	1575.4	±0.4	31.8	±1.3	554	±28	16.4	±0.9
dG exocyclic NH_2 scissors, dC (C=O s)	**j**	1608.6	±1.3	20.4	±1.0	721	±37	33.3	-
dT, dC (C=O s) (unpaired)	**k**	1650.5	±0.2	161.4	±0.9	6134	±73	36.0	±0.4
dG (C=O s) (unpaired)	**l**	1679	-	64.9	±1.4	2990	±64	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S4. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *KRAS* at pH 7.8.

Assignment*	Band	Position (cm^{-1})	Intensity	Area	FWHM
dC (ring breathing), bk	**a**	782.7 ±0.2	76.1 ±3.0	1236 ±86	15.3 ±0.6
bk [O-P-O]		794.4 ±2.7	15.9 ±2.4	703 ±103	41 ±4
bk		964.4 ±1.0	13.5 ±1.6	234 ±32	16.3 ±2.5
bk		990.9 ±0.6	23.6 ±1.6	411 ±31	16.4 ±1.4
$P(OH)O_2^-$		1087.4 ±1.6	12.1 ±1.1	491 ±48	38 ±4
dC, dG, dT		1205.3 ±1.8	33.5 ±0.9	2445 ±140	69 ±4
dT (C5-CH_3, ring s)	**b**	1240.0 ±0.8	119 ±8	1908 ±254	15.1 ±1.1
dC (C6H b, C4N s)	**c**	1254.1 ±1.1	62 ±17	930 ±495	14 ±4
dC	**d**	1268.4 ±1.8	77 ±8	1475 ±339	18.1 ±2.5
dC (N1C6, C5C6 s)	**e**	1296.0 ±0.1	130.5 ±1.7	2078 ±46	15.0 ±0.4
dG (N7C8 s; C8H b)		1322.9 ±2.2	9.1 ±1.4	234 ±47	24 ±6
dT (C5-CH_3 s)	**f**	1373.9 ±0.1	98.8 ±1.4	2141 ±33	20.4 ±0.3
d, dG (C4N9, C5N7 s)		1418.3 ±0.7	18.1 ±1.6	292 ±28	15.1 ±1.6
d		1465.6 ±0.8	13.2 ±2.1	128 ±26	9.1 ±1.9
dG (C8H b; C8N9, N7C8 s)	**g**	1488.5 ±0.1	201.2 ±1.4	4755 ±39	22.22 ±0.22
dC (N3C4 and N1C2 s)	**h**	1529.1 ±0.1	167.2 ±1.4	3668 ±33	20.61 ±0.21
dG (C4=C5, N3C4 and C5N7 s)	**i**	1576.5 ±0.2	91.7 ±1.5	1727 ±35	17.7 ±0.4
dG exocyclic NH_2 scissors, dC (C=O s) (paired)	**j**	1621.2 ±2.3	35 ±4	1625 ±172	43.3 -
dC, dT (C=O s) (unpaired)	**k**	1652.5 ±0.4	138.0 ±2.9	5334 ±236	36.3 ±1.0
dG (C=O s) (unpaired)	**l**	1679 -	45.9 ±2.1	2115 ±95	43.3 -

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S5. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *KRAS* at pH 6.6.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), C^+, $C{\cdot}C^+$, bk	**a**	785.0	±0.1	115.9	±1.7	1931	±39	15.65	±0.28
bk [O-P-O]		805	±6	8.3	±0.8	1031	±145	117	±15
bk		993.4	±1.0	15.9	±1.3	416	±38	24.6	±2.4
d		1028.9	±1.0	12.3	±1.5	209	±30	16.0	±2.5
$P(OH)O_2^-$		1085.6	±1.9	11.1	±0.9	582	±58	50	±5
dC, C^+, $C{\cdot}C^+$, dG, dT		1192.6	±1.2	26.7	±0.9	1664	±83	59	±3
dT (C5-CH_3, ring s)	**b**	1241.3	±0.5	120	±6	2668	±224	21.0	±0.8
dC, C^+, $C{\cdot}C^+$	**d**	1265.4	±0.6	136.3	±1.8	4162	±250	28.7	±1.6
dC (N1C6, C5C6 s)	**e**	1294.4	±0.2	122.7	±2.2	1961	±67	15.0	±0.4
dG (N7C8 s; C8H b)		1325.0	±0.9	20.2	±1.3	574	±45	26.7	±2.4
dT (C5-CH_3 s)	**f**	1374.8	±0.2	127.4	±1.3	3225	±56	23.8	±0.5
dC, C^+, $C{\cdot}C^+$	**f'**	1393.6	±0.8	14.7	±2.6	148	±45	9.5	±2.1
d, dG (C4N9, C5N7 s)		1416.3	±0.6	25.1	±1.4	584	±38	21.9	±1.7
d		1468.5	±0.8	14.1	±2.2	133	±29	8.9	±1.8
dG (C8H b; C8N9, N7C8 s)	**g**	1487.2	±0.1	189.7	±1.5	3961	±40	19.62	±0.23
dC (N3C4 and N1C2 s)	**h**	1529.1	-	110.4	±1.5	2332	±41	19.8	±0.4
dC, C^+, $C{\cdot}C^+$	**h'**	1543.5	-	32.4	±2.2	455	±31	13.2	±0.9
dG (C4=C5, N3C4 and C5N7 s)	**i**	1575.9	±0.2	70.4	±1.6	1164	±29	15.5	±0.4
dG exocyclic NH_2 scissors, dC (C=O s)	**j**	1615	±5	7.9	±2.1	279	±76	33.3	-
dT, dC (C=O s) (unpaired)	**k**	1651.4	±0.2	152.6	±1.1	6175	±138	38.0	±0.8
dG (C=O s) (unpaired)	**l**	1679	-	48.2	±2.1	2223	±95	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S6. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *KRAS* at pH 5.2.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), C^+, $C{\cdot}C^+$, bk	**a**	786.0	±0.1	147.9	±3.0	2317	±82	14.7	±0.3
bk [O-P-O]		794.3	±1.5	22.5	±2.8	985	±93	41.1	±2.8
bk		1007.7	±1.1	18.5	±1.0	828	±49	42.0	±2.6
bk		1028.9	±1.2	18.8	±2.6	296	±63	14.8	±2.8
$P(OH)O_2^-$		1086.7	±1.9	10.2	±1.0	429	±47	40	±5
dC, C^+, $C{\cdot}C^+$, dG, dT		1179.0	±0.9	30.3	±0.8	2079	±70	64.5	±2.5
dT (C5-CH_3, ring s)	**b**	1242.9	±0.5	96	±15	2036	±453	19.9	±1.3
dC, C^+, $C{\cdot}C^+$	**d**	1264.7	±0.9	207	±3	7860	±543	35.8	±2.0
dC (N1C6, C5C6 s)	**e**	1294.9	±0.2	83	±4	1116	±84	12.6	±0.5
dG (N7C8 s; C8H b)		1322.3	±0.7	12.2	±2.1	115	±20	8.9	±1.8
dT (C5-CH_3 s);	**f**	1378.4	±0.3	114.4	±1.3	2838	±64	23.3	±0.6
dC, C^+, $C{\cdot}C^+$	**f'**	1394.5	±0.5	21	±3	188	±50	8.4	±1.5
deoxyribose ring, dG (C4N9, C5N7 s)		1415.2	±0.8	17.6	±1.5	358	±34	19.2	±2.2
dG (C8H b; C8N9, N7C8 s)	**g**	1487.3	±0.1	170.5	±1.4	3355	±30	18.49	±0.18
dC (N3C4 and N1C2 s)	**h**	1529.1	-	56.9	±2.1	1138	±44	18.8	±0.7
dC, C^+, $C{\cdot}C^+$	**h'**	1543.5	±0.2	92.2	±2.1	1549	±37	15.8	±0.4
dG (C4=C5, N3C4 and C5N7 s)	**i**	1577.8	±0.3	44.3	±1.6	749	±31	15.9	±0.7
dG exocyclic NH_2 scissors (unpaired)	**j**	1611.0	±1.3	20.3	±1.1	719	±38	33.3	-
dT, dC (C=O s) (unpaired)	**k**	1652.6	±0.2	140.4	±1.1	4754	±70	31.8	±0.5
dG (C=O s) (unpaired)	**l**	1679	-	73.7	±1.5	3394	±67	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S7. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *BCL2* in the presence of 40% PEG 200 at pH 7.8.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), bk	**a**	781.4	±0.1	112.6	±2.0	2090	±39	17.4	±0.4
bk [O-P-O]		859.3	±0.9	14.2	±2.5	169	±30	11.2	±2.3
bk		986.4	±0.8	34.9	±1.3	1611	±66	43.4	±1.9
$P(OH)O_2^-$		1088.0	±1.5	14.8	±1.5	461	±52	29	±4
dC, dG, dT		1201.2	±1.1	43.3	±1.2	2428	±114	52.7	±2.8
dT (C5-CH_3, ring s)	**b**	1237.5	±0.9	175	±27	2766	±598	14.8	±1.0
dC (C6H b, C4N s); dA (N1C2, C8N9 s; C2H b)	**c**	1254.7	±2.2	101	±13	2084	±1506	19	±12
dC	**d**	1267.6	±1.6	72	±58	950	±961	12.3	±2.7
dC (N1C6, C5C6 s)	**e**	1294.4	±0.1	134.9	±2.2	2015	±35	14.0	±0.3
dG (N7C8 s; C8H b); dA (C5N7, N7C8 s)		1337.4	-	2.7	±1.7	47	±30	17	-
dT (C5-CH_3 s); dA	**f**	1373.3	±0.1	149.4	±1.8	3335	±43	21.0	±0.3
d, dG (C4N9, C5N7 s)		1417.0	±0.6	36.0	±1.6	1005	±49	26.3	±1.4
dG (C8H b; C8N9, N7C8s); dA (C4N9 s, C8H b)	**g**	1489.7	±0.1	214.4	±1.8	5217	±50	22.86	±0.25
dA		1509.2	-	56.6	±2.8	827	±41	13.7	-
dC (N3C4 and N1C2 s)	**h**	1527.9	±0.1	269.0	±1.8	5442	±43	19.0	±0.17
dG (C4=C5, N3C4 and C5N7 s), dA (C4C5, N3C4 s)	**i**	1575.2	±0.2	73.9	±1.9	1268	±35	16.1	±0.5
dG exocyclic NH_2 scissors, dC (C=O s) (paired)	**j**	1627.9	±2.7	41	±6	1871	±276	43.29	-
dC, dT (C=O s) (unpaired)	**k**	1653.2	±0.4	188	±6	6579	±334	32.9	±0.8
dG (C=O s) (unpaired)	**l**	1679	-	51.9	±2.2	2391	±103	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S8. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *BCL2* in the presence of 40% PEG 200 at pH 6.6.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), C^+, $C{\cdot}C^+$, bk	**a**	787.1	±0.2	110.3	±2.1	1874	±43	16.0	±0.4
d		832.0	±1.0	28.2	±1.4	1292	±72	43.1	±2.8
bk		888.2	±0.5	34.5	±2.0	618	±39	16.9	±1.2
bk		997.0	±1.6	14.5	±1.8	354	±56	23	±4
dA(NH_2 b, C2N3 s)		1032.6	±2.0	13.8	±1.8	357	±75	24	±6
$P(OH)O_2^-$		1069.7	±1.2	23.8	±1.6	727	±70	29	±3
d,dT		1136.0	±1.1	18.3	±1.7	497	±49	25.6	±2.8
dC, C^+, $C{\cdot}C^+$, dG, dT		1200.8	±1.2	29.8	±1.4	1222	±88	39	±3
dT (C5-CH_3, ring s)	**b**	1243.9	±0.3	188.8	±1.9	5093	±148	25.3	±0.7
dC, C^+, $C{\cdot}C^+$	**d**	1268.8	±0.4	172	±3	4277	±79	23	-
dC (N1C6, C5C6 s)	**e**	1293.9	±0.2	183.4	±1.9	4032	±75	20.7	±0.4
dT (C5-CH_3 s); dA	**f**	1376.2	±0.2	131.0	±1.8	3180	±62	22.8	±0.5
dC, C^+, $C{\cdot}C^+$	**f'**	1394.6	±0.7	18	±3	150	±43	7.8	±1.9
d, dG (C4N9, C5N7 s)		1416.3	±1.0	17.1	±2.0	325	±41	17.8	±2.6
d		1567	±5	35	±9	979	±452	26	±6
dG (C8H b; C8N9, N7C8 s); dA (C4N9 s, C8H b)	**g**	1486.3	±0.9	144	±14	3325	±449	21.7	±1.0
dA		1509.2	-	8	-	116	-	13	-
dC (N3C4 and N1C2 s)	**h**	1527.9	-	114.1	±2.4	1875	±43	15.4	±0.4
dC, C^+, $C{\cdot}C^+$	**h'**	1542.9	-	68.7	±2.6	1031	±41	14.1	±0.6
dG (C4=C5, N3C4 and C5N7 s), dA (C4C5, N3C4 s)	**i**	1576.8	±0.3	53.5	±2.2	839	±39	14.8	±0.7
dG exocyclic NH_2 scissors	**j**	1610.7	±2.0	20.2	±1.7	715	±59	33	-
dT, dC (C=O s) (unpaired)	**k**	1652.4	±0.2	171.4	±1.5	6544	±126	36.9	±0.7
dG (C=O s) (unpaired)	**l**	1679	-	60.3	±2.4	2778	±111	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S9. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *BCL2* in the presence of 40% PEG 200 at pH 5.2.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), C^+, $C{\cdot}C^+$, bk	**a**	785.3	±0.1	140	±3	2157	±81	14.5	±0.4
bk [O-P-O]		792.2	±1.3	29.7	±2.6	1752	±106	55	±4
d		1007.6	±2.7	8.0	±1.6	230	±51	27	±7
$P(OH)O_2^-$		1090	±3	6.6	±1.7	175	±48	25	±8
dC, C^+, $C{\cdot}C^+$, dG, dT		1182.5	±1.1	29.8	±1.2	1672	±80	52.7	±2.8
dT (C5-CH_3, ring s)	**b**	1242.9	±0.9	141	±15	3260	±478	21.7	±1.1
dC, C^+, $C{\cdot}C^+$	**d**	1264.9	±0.9	201	±5	5953	±540	27.9	±1.9
dC (N1C6, C5C6 s)	**e**	1292.2	±0.3	76	±4	1128	±94	14.0	±0.8
dT (C5-CH_3 s); dA	**f**	1375.6	±1.1	108	±5	2503	±265	21.7	±1.5
dC, C^+, $C{\cdot}C^+$	**f'**	1392.1	±1.7	38	±11	632	±309	16	±3
d, dG (C4N9, C5N7 s)		1417.5	±2.0	27.2	±1.6	938	±122	32	±4
dG (C8H b; C8N9, N7C8 s); dA (C4N9 s, C8H b)	**g**	1486.8	±0.1	124.5	±2.1	2182	±39	16.5	±0.3
dA		1509.2	-	15.3	±2.5	225	±36	13.7	-
dC (N3C4 and N1C2 s)	**h**	1527.9	-	49	±4	891	±81	17.2	±1.3
dC, C^+, $C{\cdot}C^+$	**h'**	1542.9	±0.3	112.8	±2.7	2380	±75	19.8	±0.7
dG (C4=C5, N3C4 and C5N7 s), dA (C4C5, N3C4 s)	**i**	1573.7	±0.5	30	±3	380	±59	11.8	±1.4
dG exocyclic NH_2 scissors (unpaired)	**j**	1591	±4	11.8	±1.7	418	±61	33.3	-
dT, dC (C=O s) (unpaired)	**k**	1651.2	±0.2	143.9	±1.6	4799	±73	31.3	±0.5
dG (C=O s) (unpaired)	**l**	1679	-	84.6	±1.8	3901	±81	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S10. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *KRAS* in the presence of 40% PEG 200 at pH 7.8.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), bk	**a**	781.9	±0.2	64.9	±1.8	941	±31	13.6	±0.5
d		835.0	±1.7	16.0	±1.0	968	±75	57	±5
bk		885.0	±0.5	24.7	±1.7	425	±38	16.2	±1.5
bk		990.5	±0.6	25.6	±1.4	575	±35	21.1	±1.4
dG(NH_2 b, C2N3 s)		1029.6	±0.9	17.7	±1.5	365	±43	19.3	±2.2
d		1069.0	±1.4	16.5	±1.1	669	±58	38	±4
d, dT		1129.5	±1.0	14.7	±1.3	365	±36	23.3	±2.5
dC, dG, dT		1211.3	±2.2	29.4	±1.1	1404	±146	45	±4
dT (C5-CH_3, ring s)	**b**	1238.9	±0.3	155	±4	2843	±187	17.3	±0.8
dC (C6H b, C4N s)	**c**	1253.2	±0.6	54	±15	651	±280	11.4	±1.8
dC	**d**	1266.9	±0.8	108.3	±2.7	2379	±289	20.6	±2.2
dC (N1C6, C5C6 s)	**e**	1293.2	±0.2	142.8	±1.7	2824	±88	18.6	±0.6
dG (N7C8 s; C8H b); dA (C5N7, N7C8 s)		1320.8	±1.4	11.4	±1.5	217	±39	18	±4
dT (C5-CH_3 s)	**f**	1372.7	±0.1	100.7	±1.4	2142	±33	20.0	±0.3
d, dG (C4N9, C5N7 s)		1416.3	±0.7	17.9	±1.6	303	±29	15.9	±1.7
d		1458.5	±0.5	32.9	±1.5	584	±27	16.6	-
dG (C8H b; C8N9, N7C8 s)	**g**	1486.6	±0.1	181.7	±1.3	4912	±44	25.4	±0.3
dC (N3C4 and N1C2 s)	**h**	1528.2	±0.1	164.0	±1.5	3335	±33	19.11	±0.21
dG (C4=C5, N3C4 and C5N7 s)	**i**	1575.4	±0.2	90.5	±1.6	1690	±38	17.6	±0.4
dG exocyclic NH_2 scissors, dC (C=O s) (paired)	**j**	1616.6	±2.3	29.5	±2.6	1361	±120	43.3	-
dC, dT (C=O s) (unpaired)	**k**	1651.9	±0.3	142.4	±1.9	5607	±186	37.0	±0.9
dG (C=O s) (unpaired)	**l**	1679	-	33.0	±2.1	1522	±95	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S11. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *KRAS* in the presence of 40% PEG 200 at pH 6.6.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), C^+, $C{\cdot}C^+$, bk	**a**	784.8	±0.1	111.0	±2.1	1866	±36	15.8	±0.3
bk		991	±4	8.5	±1.5	304	±75	34	±10
d		1028	±3	7.6	±1.8	179	±63	22	±8
$P(OH)O_2^-$		1079.2	±1.4	14.6	±1.6	399	±48	26	±3
dC, C^+, $C{\cdot}C^+$, dG, dT		1193.2	±1.7	22.7	±1.2	1339	±93	56	±4
dT (C5-CH_3, ring s)	**b**	1239.1	±0.4	103	±10	1960	±278	17.9	±1.0
dC, C^+, $C{\cdot}C^+$	**d**	1262.3	±0.8	139.6	±1.8	4981	±342	33.5	±2.3
dC (N1C6, C5C6 s)	**e**	1293.4	±0.2	111	±3	1642	±81	13.9	±0.5
dG (N7C8 s; C8H b); dA (C5N7, N7C8 s)		1320.8	±0.7	22.0	±2.3	303	±32	12.9	±1.6
dT (C5-CH_3 s)	**f**	1374.1	±0.2	120.8	±1.9	2618	±56	20.4	±0.5
C^+, $C{\cdot}C^+$	**f'**	1390.3	±0.6	19	±4	133	±40	6.6	±1.6
d, dG (C4N9, C5N7 s)		1413.6	±0.9	24.7	±1.7	689	±51	25.4	±2.3
dG (C8H b; C8N9, N7C8 s)	**g**	1486.2	±0.1	233.3	±1.8	5184	±42	20.87	±0.19
dC (N3C4 and N1C2 s)	**h**	1528.2	-	124.4	±2.0	2796	±57	21.1	±0.5
dC, C^+, $C{\cdot}C^+$	**h'**	1542.4	-	41.6	±3.0	551	±42	12.4	±0.9
dG (C4=C5, N3C4 and C5N7 s)	**i**	1575.5	±0.2	103.0	±1.9	2151	±42	19.6	±0.4
dG exocyclic NH_2 scissors	**j**	1618.0	±1.2	35.5	±1.9	1260	±68	33	-
dT, dC (C=O s) (unpaired)	**k**	1652.1	±0.2	145.7	±1.6	4740	±110	30.6	±0.7
dG (C=O s) (unpaired)	**l**	1679	-	60.7	±1.8	2298	±83	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

Table S12. Assignment, frequency, intensity, area, and width for the indicated UVRR bands of *KRAS* in the presence of 40% PEG 200 at pH 5.2.

Assignment*	Band	Position (cm^{-1})		Intensity		Area		FWHM	
dC (ring breathing), C^+, $C{\cdot}C^+$, bk	**a**	785.2	±0.1	142	±3	2333	±91	15.5	±0.4
bk [O-P-O]		810	±4	14.7	±1.5	869	±141	56	±7
d		1006	±10	2.1	±1.9	50	±49	23	±24
dC, C^+, $C{\cdot}C^+$, dG, dT		1180.0	±1.0	31	±1.3	1632	±79	49.0	±2.6
dT (C5-CH_3, ring s)	**b**	1242.5	±1.0	130	±11	3100	±414	22.4	±1.2
dC, C^+, $C{\cdot}C^+$	**d**	1265.3	±1.0	164	±5	4838	±451	28	±1.9
dC (N1C6, C5C6 s)	**e**	1292.6	±0.3	73	±3	867	±65	11.5	±0.6
dG (N7C8 s; C8H b); dA (C5N7, N7C8 s)		1322.4	±0.6	23.4	±2.9	236	±30	9.5	±1.4
dT (C5-CH_3 s)	**f**	1376.0	±0.3	108.4	±1.9	2697	±80	23.3	±0.8
dC, C^+, $C{\cdot}C^+$	**f'**	1392.9	±0.8	19	±4	162	±64	8.0	±2.2
d, dG (C4N9, C5N7 s)		1412.4	±1.4	18.8	±1.9	462	±63	23	±4
dG (C8H b; C8N9, N7C8 s)	**g**	1484.8	±0.1	211.4	±2.1	4221	±44	18.76	±0.21
dC (N3C4 and N1C2 s)	**h**	1528.2	-	78.3	±2.8	1392	±50	15.4	±1.2
dC, C^+, $C{\cdot}C^+$	**h'**	1542.4	±0.3	85.3	±2.3	1393	±50	15.4	±0.6
dG (C4=C5, N3C4 and C5N7 s)	**i**	1576.1	±0.3	68.9	±2.2	1248	±44	17.0	±0.7
dG exocyclic NH_2 scissors	**j**	1612.4	±1.7	22.7	±1.5	804	±54	33.3	-
dT, dC (C=O s) (unpaired)	**k**	1651.8	±0.2	135.4	±1.7	4201	±86	29.2	±0.6
dG (C=O s) (unpaired)	**l**	1679	-	70.4	±1.8	3245	±83	43.3	-

*bk, deoxyribose-phosphate backbone; d, deoxyribose ring.

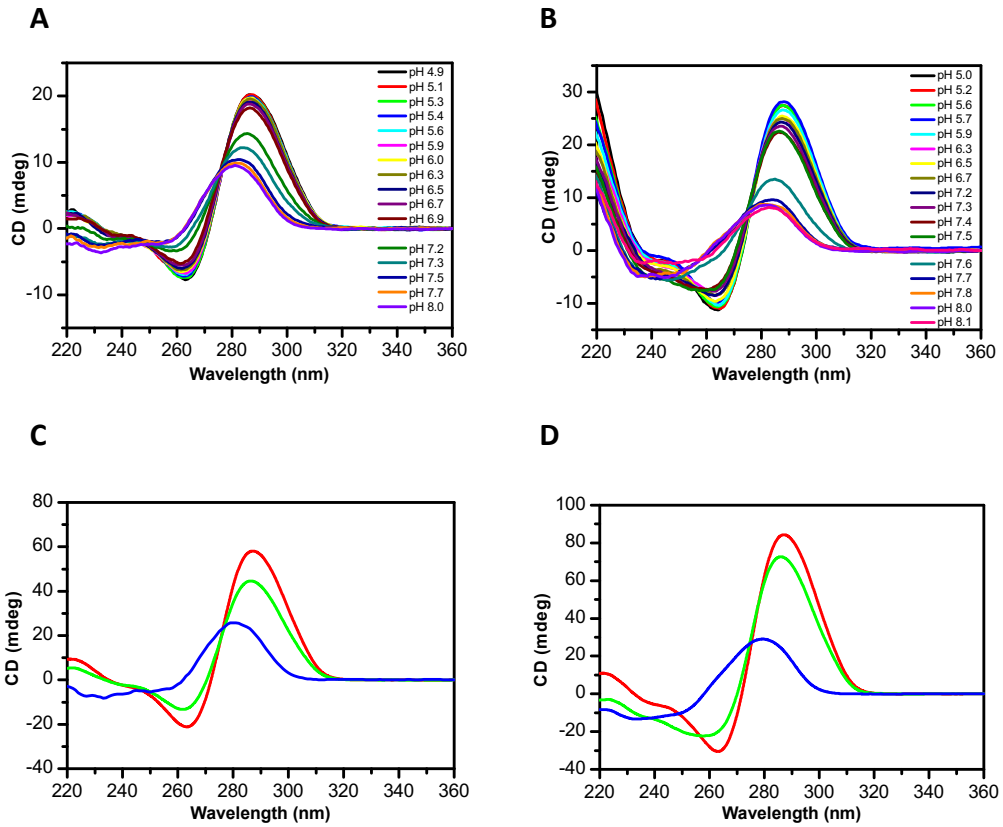

Fig. S3 CD spectra of (A) *BCL2* and (B) *KRAS* oligonucleotides (15 µM) as a function of pH; and CD spectra of (C) *BCL2* and (D) *KRAS* (40 µM) at pH 7.8 (blue), 6.6 (green), and 5.2 (red). T = 10 °C.

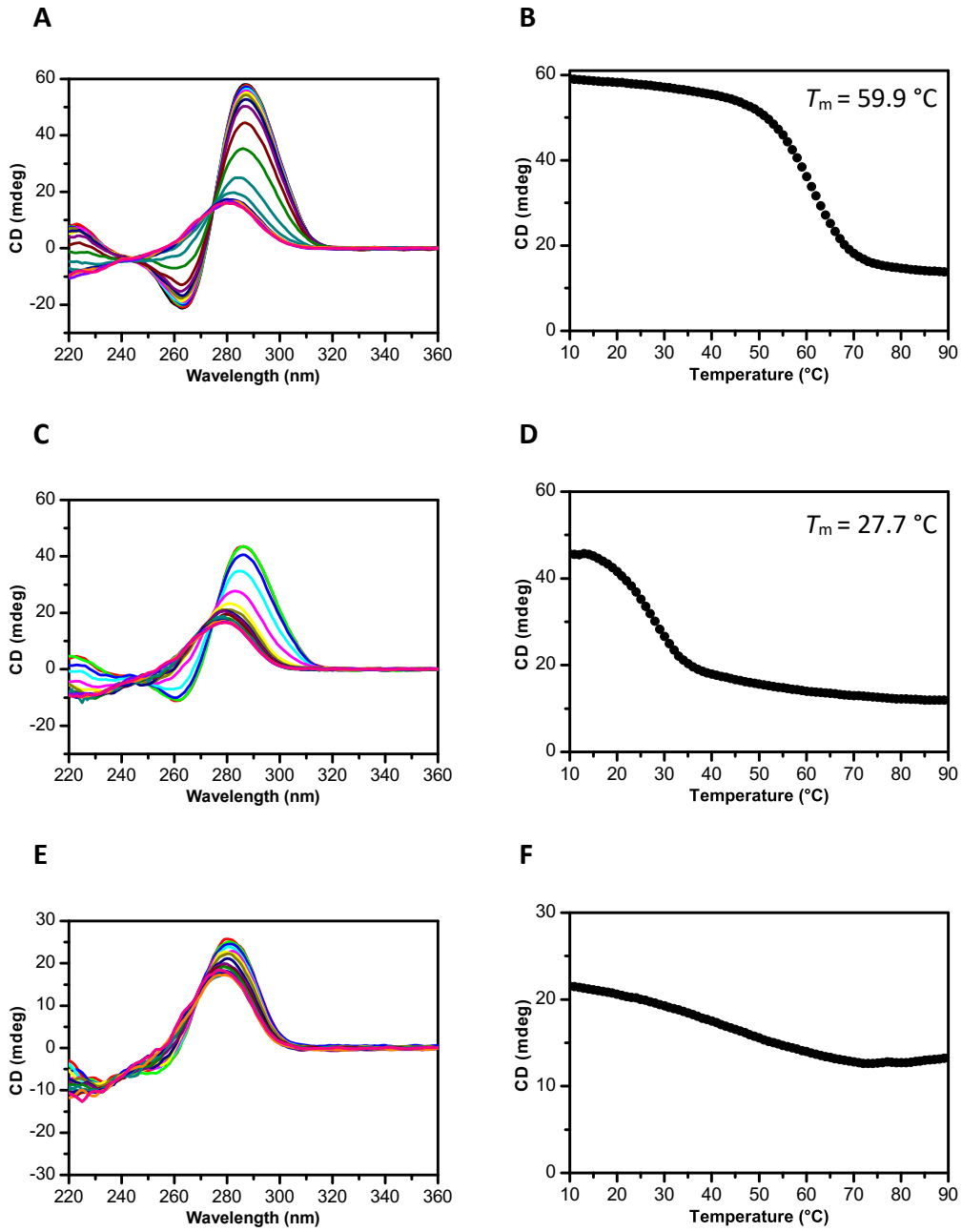

Fig. S4 CD spectra of *BCL2* oligonucleotide (40 µM) as a function of temperature (collected from 10 to 90 °C with a step of 5 °C) in dilute solution at pH (A) 5.2, (C) 6.6, and (E) 7.8, with (B,D,F) respective plots of the CD signal (at the wavelength of maximum absorbance) versus temperature used to determine the melting temperature (T_m). The error in T_m values was ±0.5 °C.

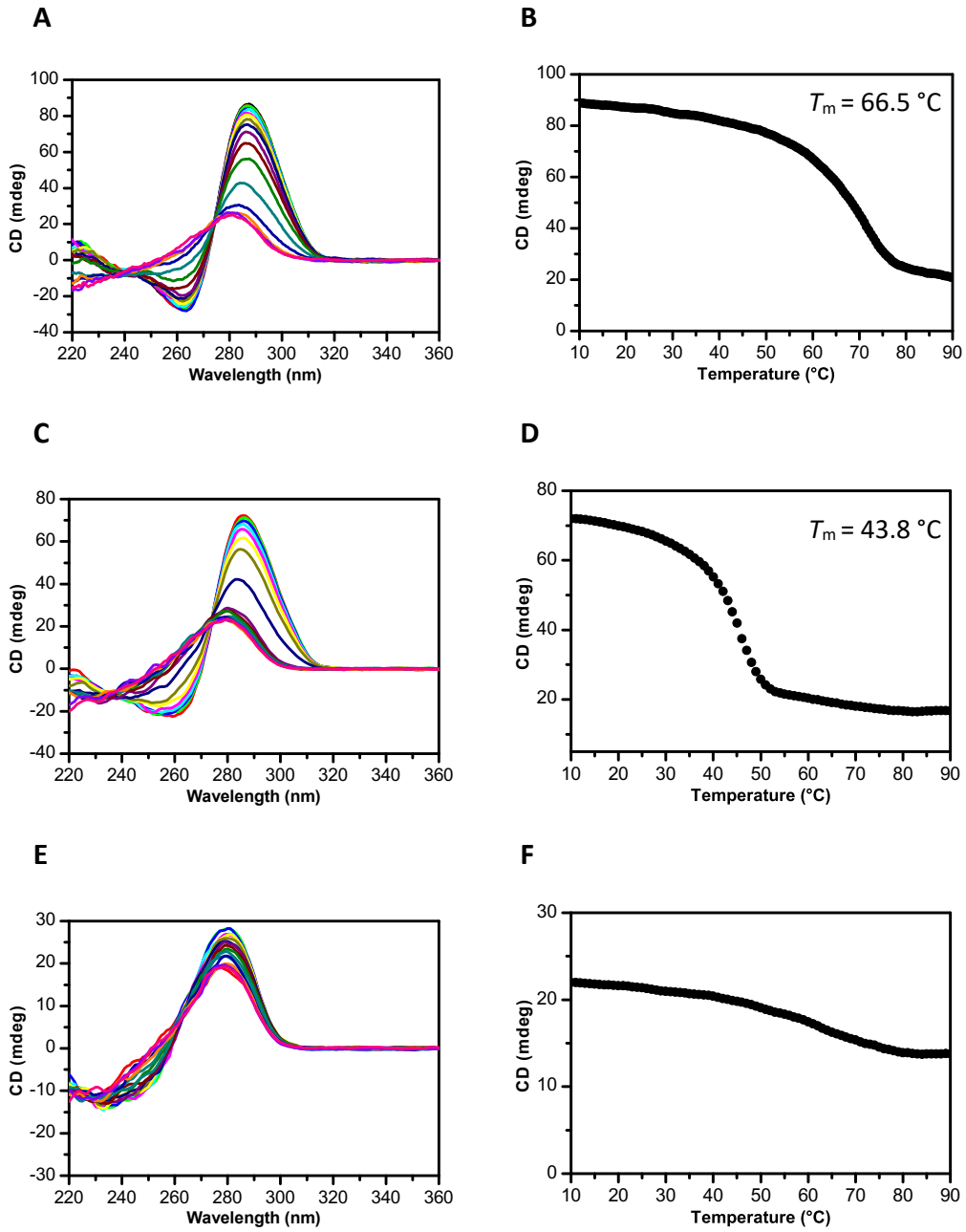

Fig. S5 CD spectra of *KRAS* oligonucleotide (40 µM) as a function of temperature (collected from 10 to 90 °C with a step of 5 °C) in dilute solution at pH (A) 5.2, (C) 6.6, and (E) 7.8, with (B,D,F) respective plots of the CD signal (at the wavelength of maximum absorbance) versus temperature used to determine the melting temperature (T_m). The error in T_m values was ±0.5 °C.

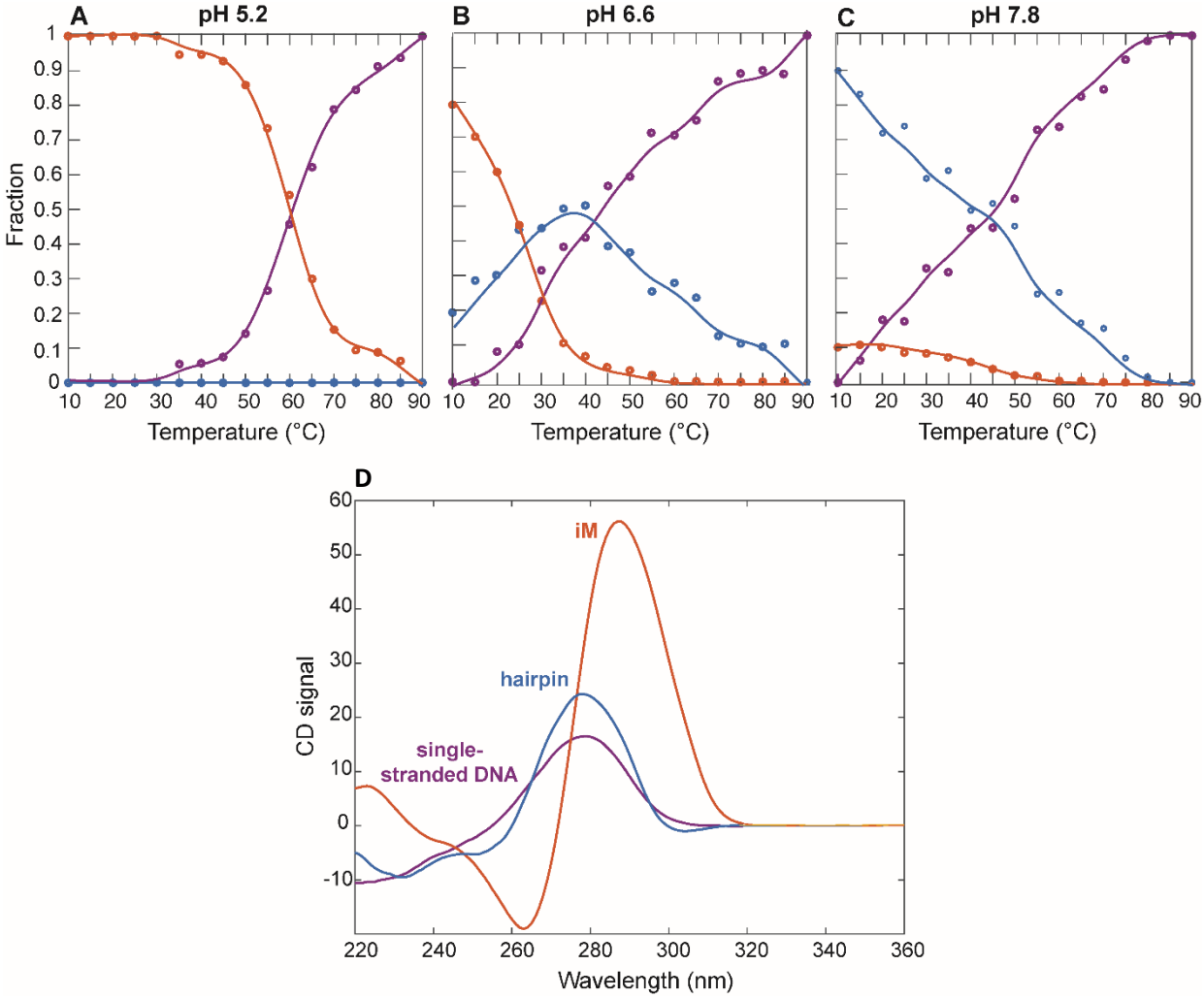

Fig. S6 MCR-ALS-resolved concentration profiles for the simultaneous data analysis of *BCL2* melting experiments at pH (A) 5.2, (B) 6.6, and (C) 7.8. Circles represent experimental points. (D) MCR-ALS-resolved spectral profiles. Orange line, i-motif (iM); blue line, hairpin; purple line, single-stranded DNA.

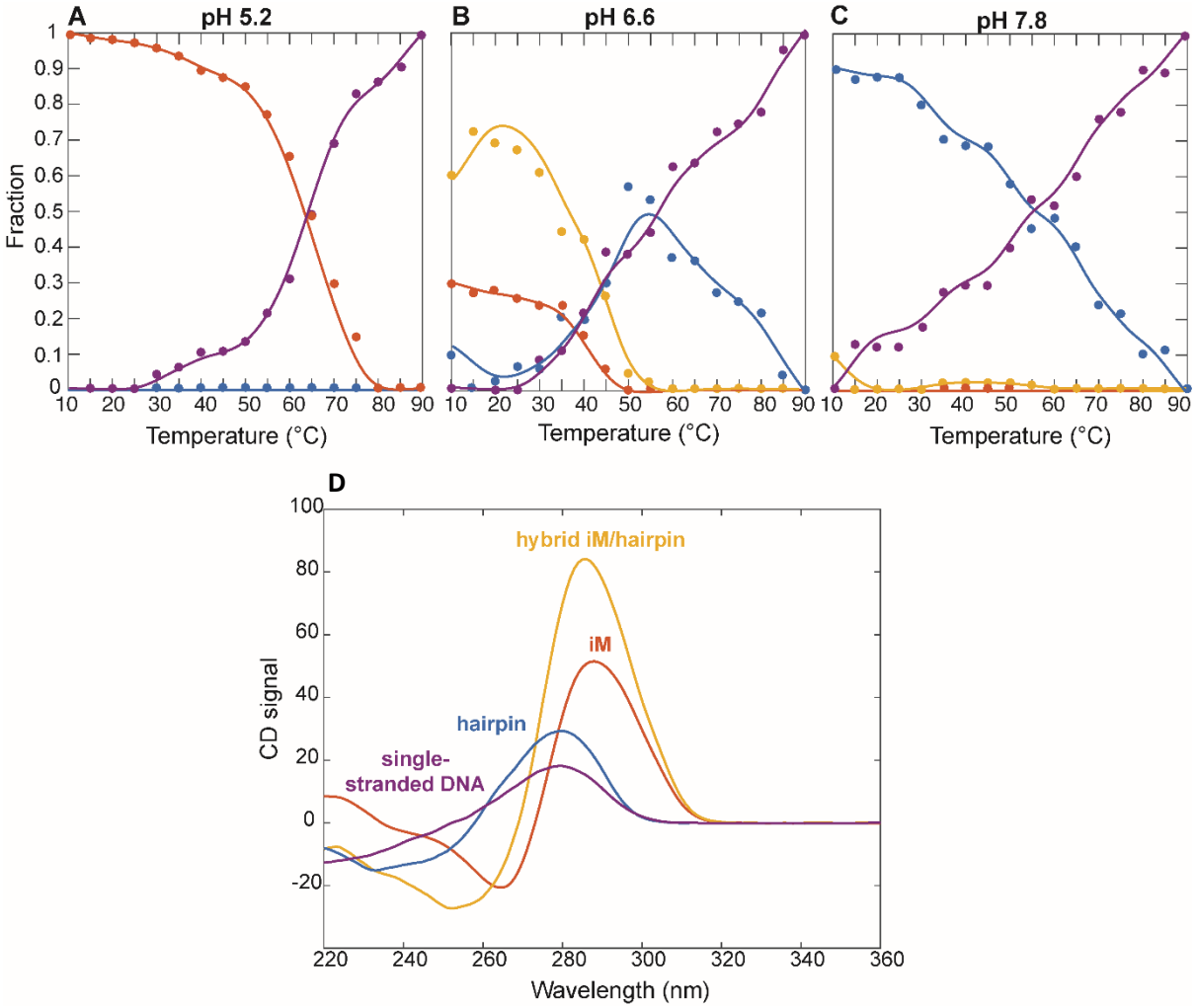

Fig. S7 MCR-ALS-resolved concentration profiles for the simultaneous data analysis of *KRAS* melting experiments at pH (A) 5.2, (B) 6.6, and (C) 7.8. Circles represent experimental points. (D) MCR-ALS-resolved spectral profiles. Orange line, i-motif (iM); yellow line, hybrid i-motif/hairpin species; blue line, hairpin; purple line, single-stranded DNA.

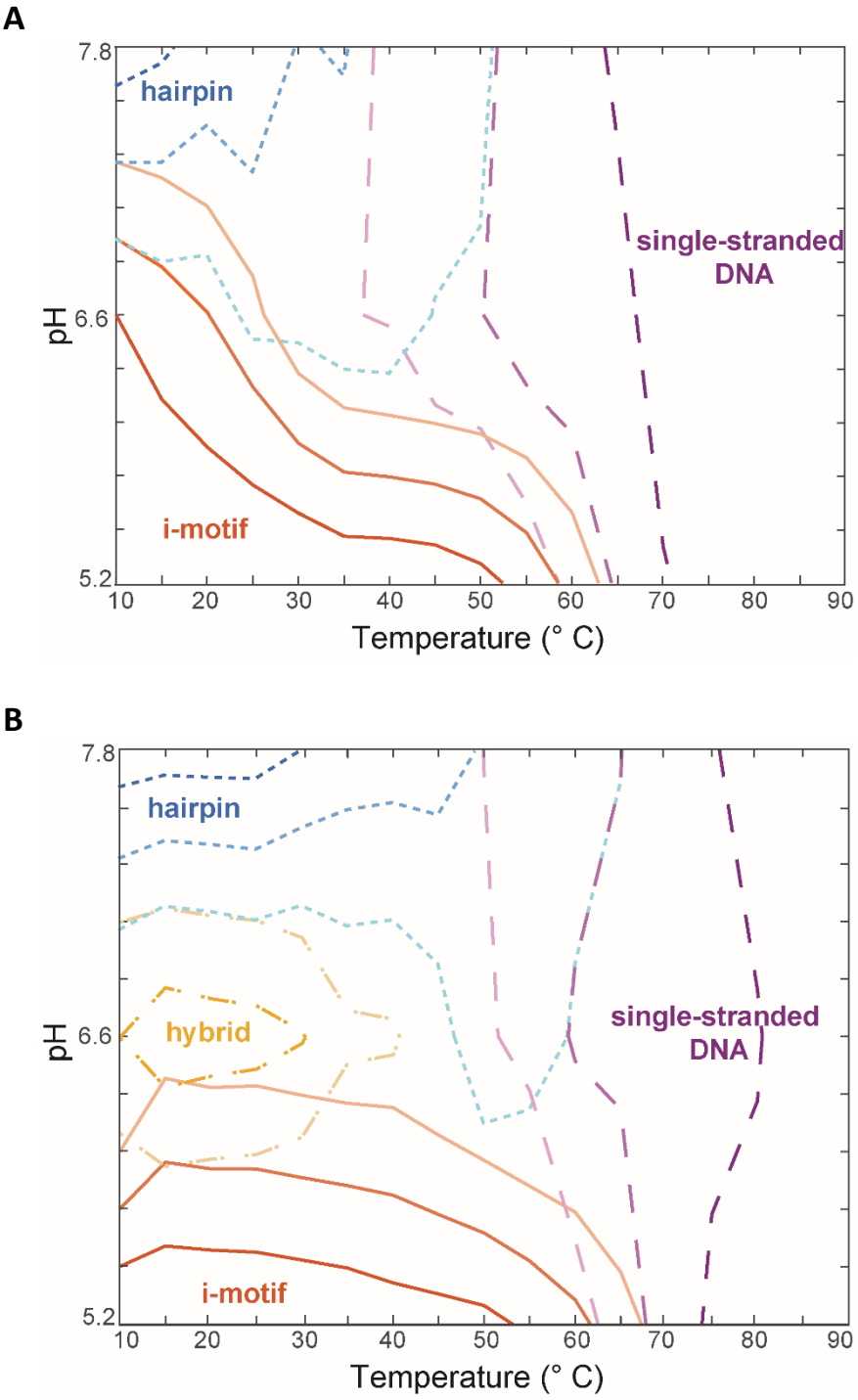

Fig. S8 Superimposition of the (A) three and (B) four contour plots obtained from the MCR-resolved concentration profiles for the analysis of (A) *BCL2* and (B) *KRAS* 3D melting at three pH values monitored by CD spectroscopy. I-motif: solid line; hairpin: short-dashed line; single-stranded DNA: long-dashed line; hybrid: dash-dotted line. The different color shades represent the three selected threshold levels, from fraction 0.8 (darker) up to fraction 0.4 (lighter) with steps of 0.2. For the hybrid species (B) there are only two curves as it does not reach the value of 0.8.

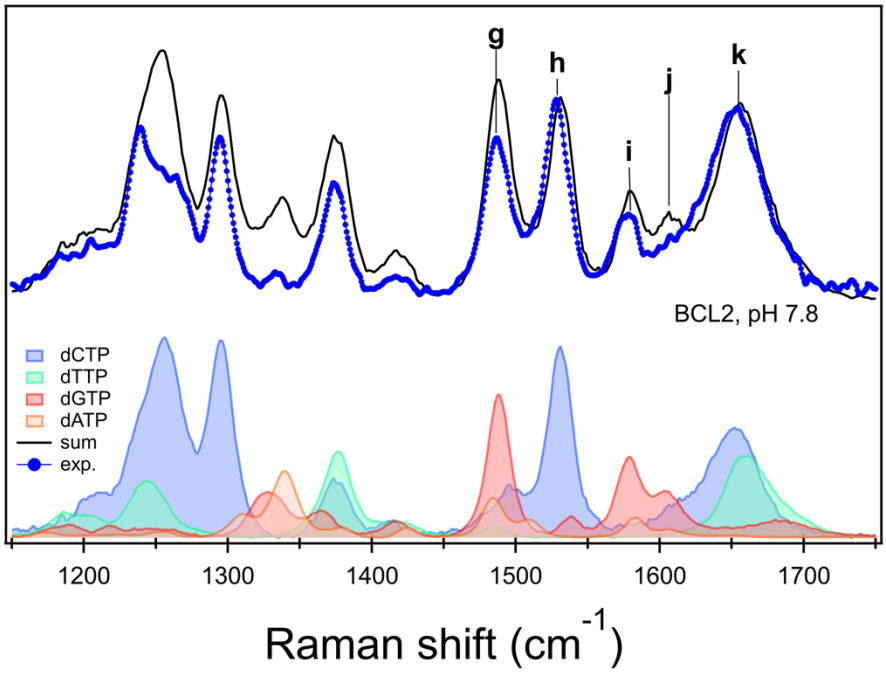

Fig. S9 Top: Experimental UVRR spectrum of *BCL2* at pH 7.8 (blue line). Bottom: UVRR spectra of the nucleotides constituting the oligonucleotide weighted considering their occurrence in the *BCL2* sequence (dCTP: cyan; dGTP: red; dTTP: green; dATP: orange). The sum spectrum is shown in black (top).

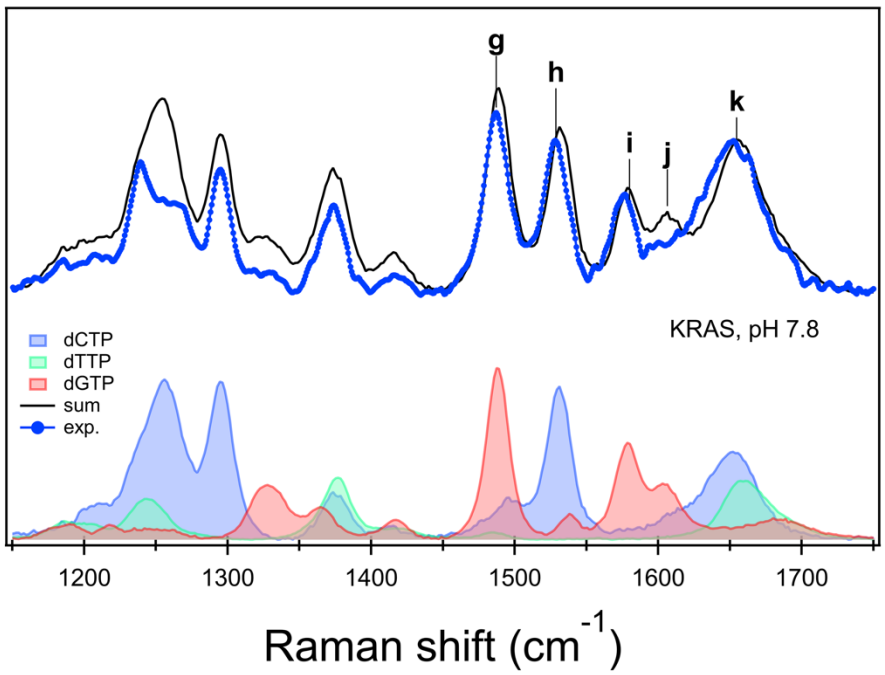

Fig. S10 Top: Experimental UVRR spectrum of *KRAS* at pH 7.8 (blue line). Bottom: UVRR spectra of the nucleotides constituting the oligonucleotide weighted considering their occurrence in the *KRAS* sequence (dCTP: cyan; dGTP: red; dTTP: green). The sum spectrum is shown in black (top).

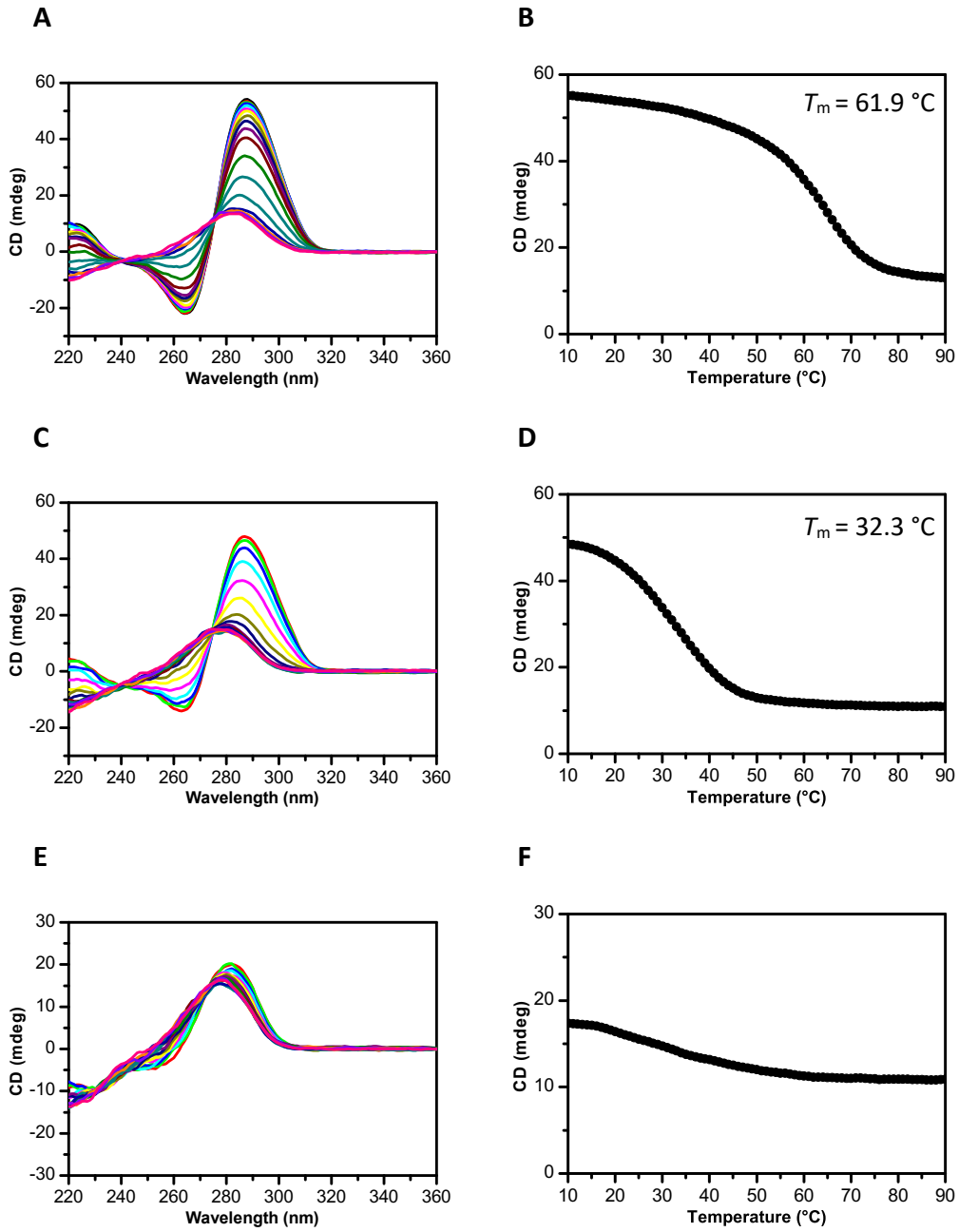

Fig. S11 CD spectra of *BCL2* oligonucleotide (36 µM) as a function of temperature (collected from 10 to 90 °C with a step of 5 °C) in PEG 200-crowded solution at pH (A) 5.2, (C) 6.6, and (E) 7.8, with (B,D,F) respective plots of the CD signal (at the wavelength of maximum absorbance) versus temperature used to determine the melting temperature (T_m). The error in T_m values was ±0.5 °C.

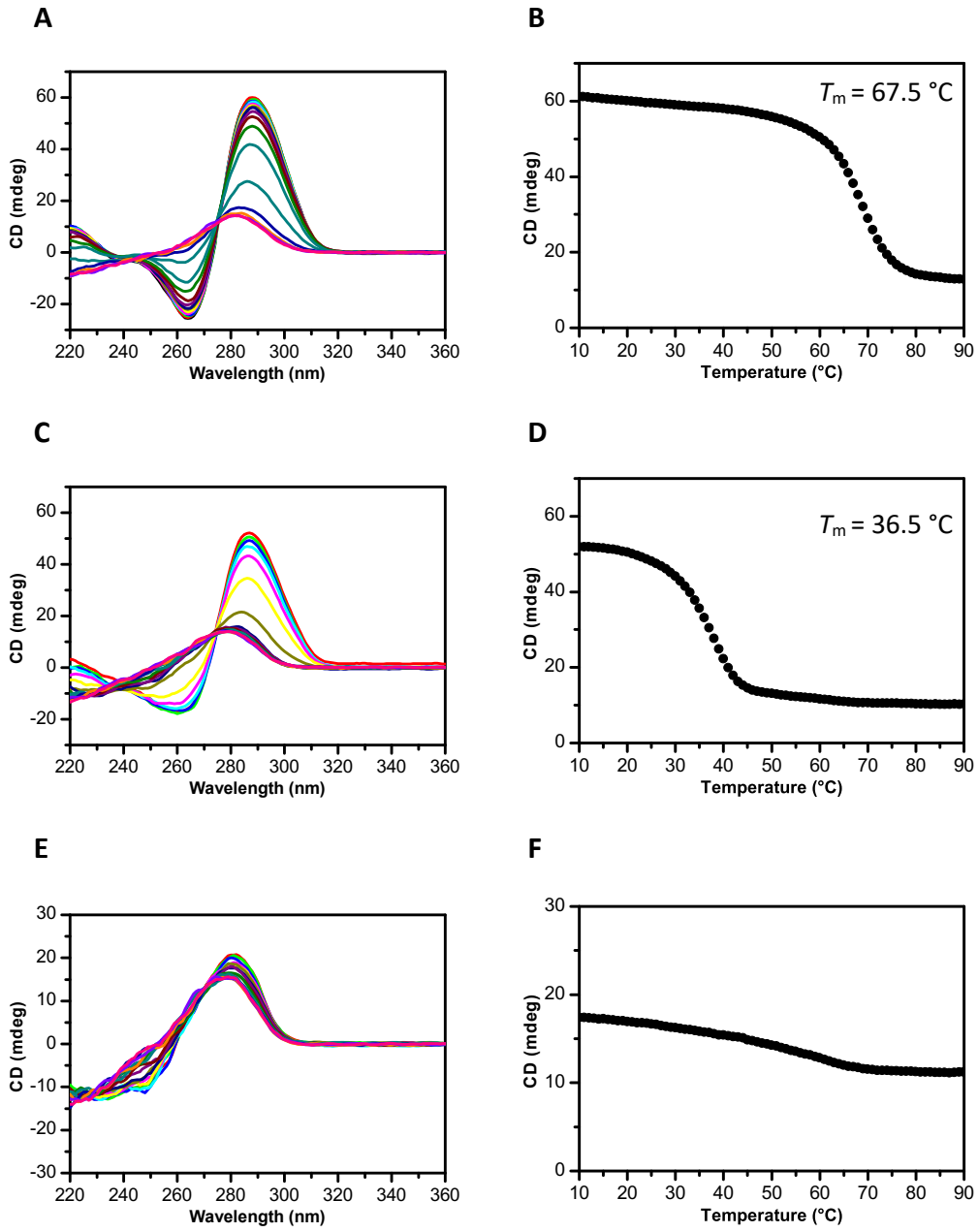

Fig. S12 CD spectra of *KRAS* oligonucleotide (32 µM) as a function of temperature (collected from 10 to 90 °C with a step of 5 °C) in PEG 200-crowded solution at pH (A) 5.2, (C) 6.6, and (E) 7.8, with (B,D,F) respective plots of the CD signal (at the wavelength of maximum absorbance) versus temperature used to determine the melting temperature (T_m). The error in T_m values was ±0.5 °C.

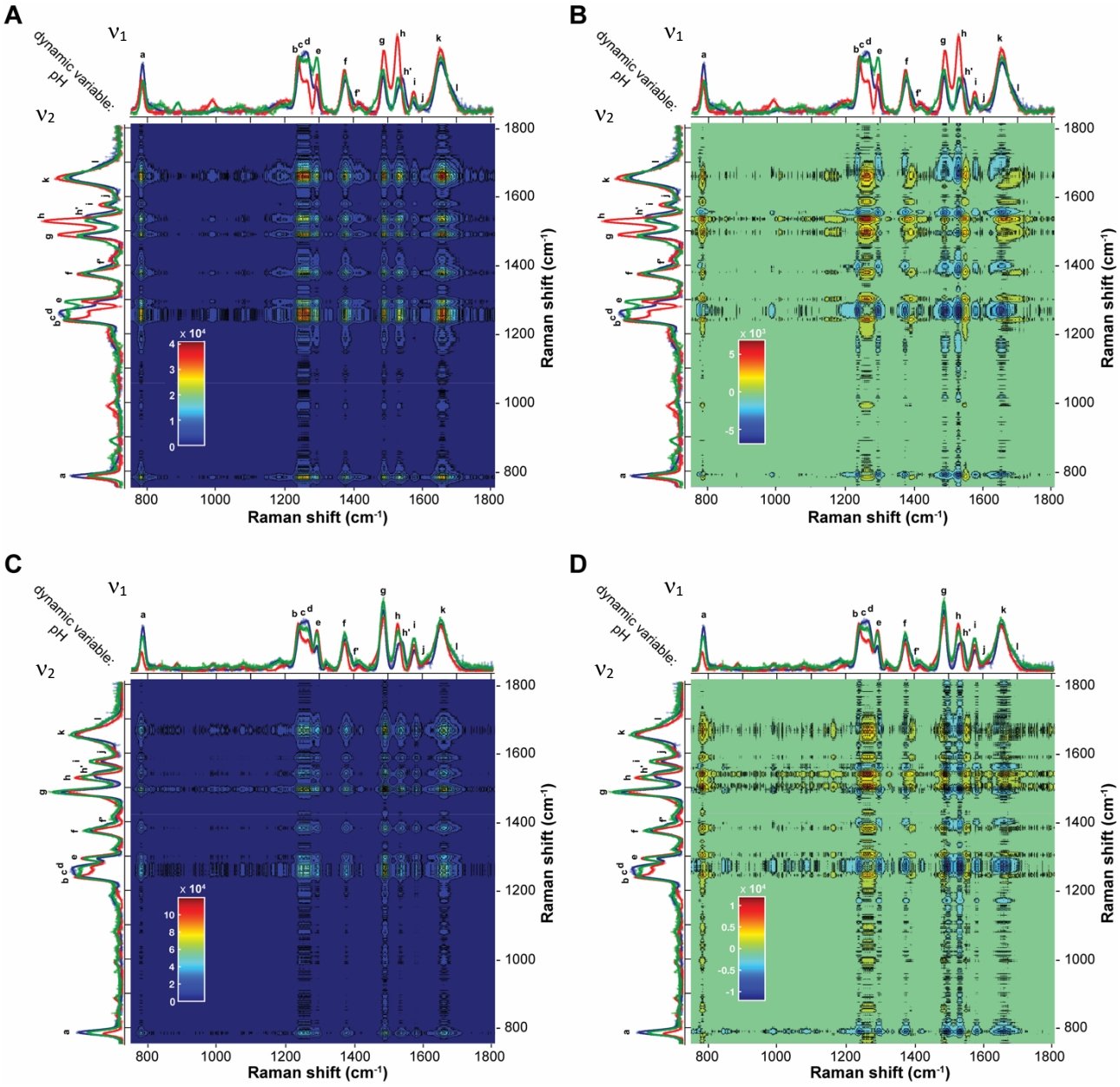

Fig. S13 Synchronous (A, C) and asynchronous (B, D) 2D UVRR correlation maps generated from the pH-dependent spectra of *BCL2* (top) and *KRAS* (bottom) in PEG 200-crowded solution. The color bar that applies to each map is displayed at the bottom left of the map.