Supporting Information: Pushing the Resolving Power of Tyndall-Powell Gate Ion Mobility Spectrometry over 100 with No Sensitivity Loss for Multiple Ion Species

Chuang Chen[†], Hong Chen[†,‡], and Haiyang Li[†,*]

[†]Key Laboratory of Separation Science for Analytical Chemistry, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, Dalian, 116023, People's Republic of China

[‡]University of Chinese Academy of Sciences, Beijing, 100039, People's Republic of China

[*]Corresponding author. Haiyang Li, Tel.: +86-411-84379510, e-mail: hli@dicp.ac.cn

Abstract

This supporting information provides additional information on the following aspects: features of the electric field around the TPG at open and closed statuses (Figure S-1); evidence proving the width of the ion depletion zone along *x* direction gets smaller as enhancing the GPV at the TPG closed status (Figure S-2); evidence proving the electric field in the TPG gate region gets stronger as enhancing the GPV at the TPG open status (Figure S-3); ion mobility spectra for ammonium, DMMP dimer, and acetone dimer, respectively (Figure S-4); explanation of the resolving power improvement effect of the GPV (Figure S-5, Table S-1, and Table S-2); the relationship between the TPG ion transmission efficiency and the GPV (Figure S-6).

1. Features of the electric field around the TPG at open and closed statuses.

As shown in Figure S-1, when the TPG is open, the *x*-component of the electric field E_x is higher than 0 in all the displayed regions, driving the positive ions in the ionization region to go through the TPG and enter the ion drift region. While, when the TPG is closed, the electric field E_x in the TPG gate region becomes lower than 0, meaning the direction of the electric field was reversed to be along *-x*. That would prevent the positive ions in the ionization region from going through the TPG. Here, the zone with $E_x < 0$ is named the ion depletion zone.

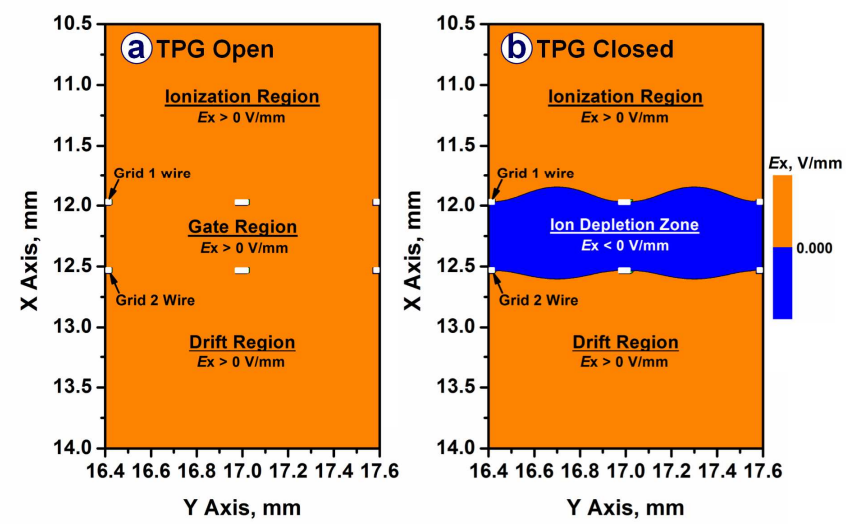

Figure S-1. The electric field features in the vicinity of the TPG at (a) open and (b) closed statuses. At the TPG open status, potentials of 755 V, 440 V, 400 V, and 85 V were applied to Electrode 1, Grid 1, Grid 2, and Electrode 2; at the TPG closed status, the potential on Grid 2 was switched to 620 V.

2. Evidence proving the width of the ion depletion zone along *x* direction gets smaller as enhancing the GPV at the TPG closed status.

As shown in Figure S-2, along each *y* line parallel to $y = 17.30$ mm, the E_x versus *x* plots as the GPV varying from 0 V to 144 V show the similar appearance as displayed in Figure 2a of the primary article, proving that the size of the width of the ion depletion zone along *x* direction gets smaller by changing the GPV.

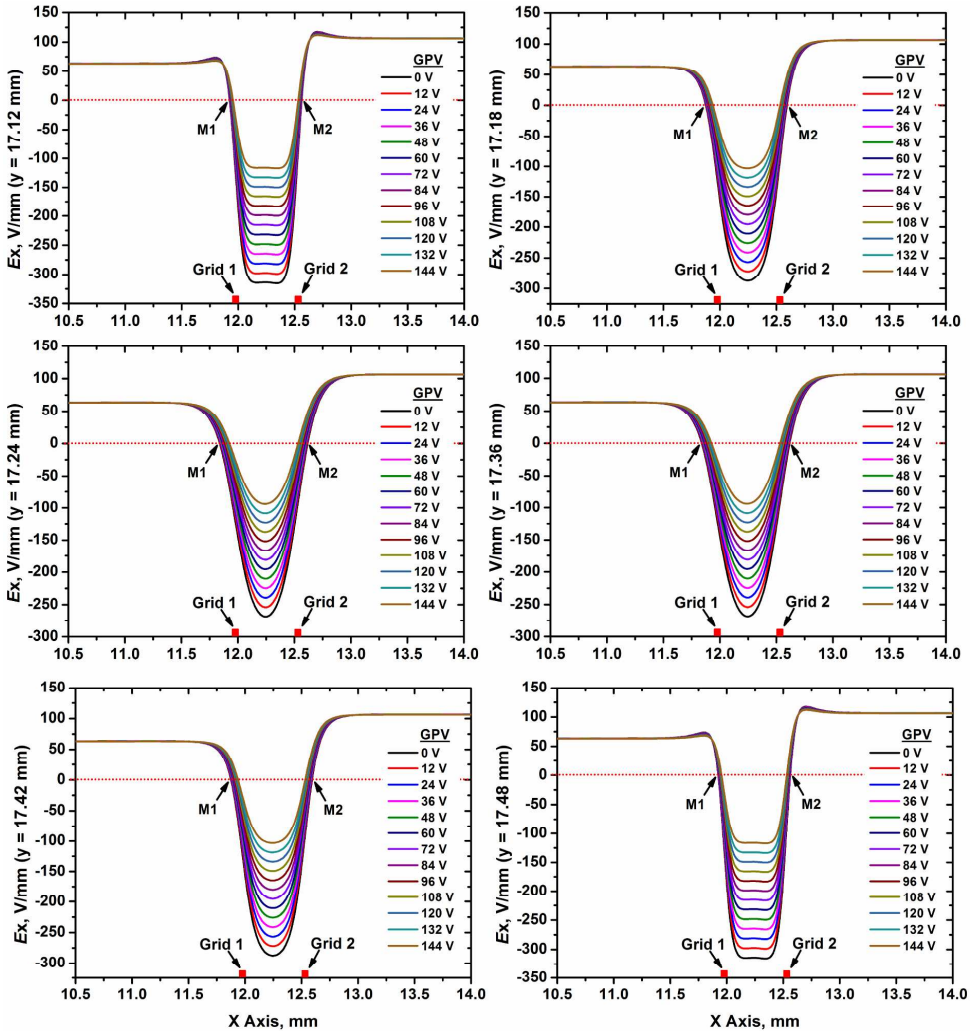

Figure S-2. E_x versus x plots as the GPV varying from 0 V to 144 V along y = 17.12 mm, y = 17.18 mm, y = 17.24 mm, y = 17.36 mm, y = 17.42 mm, and y = 17.48 mm, respectively, at the TPG closed status.

3. Evidence proving the electric field in the TPG gate region gets stronger as enhancing the GPV at the TPG open status.

As shown in Figure S-3, along each y line parallel to y = 17.30 mm, the E_x versus x plots as the GPV varying from 0 V to 144 V show the similar appearance as displayed in Figure 2b of the primary article, proving that the electric field in the TPG gate region gets stronger as enhancing the GPV.

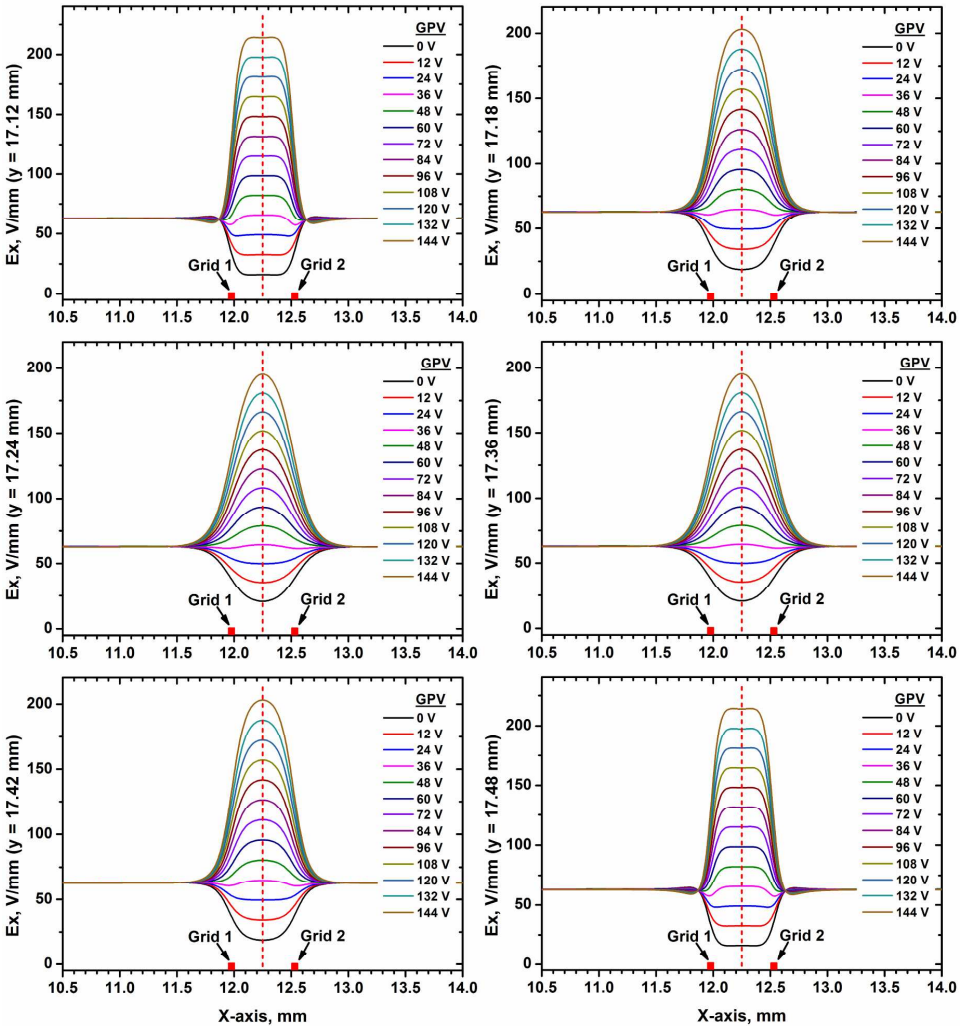

Figure S-3. E_x versus x plots as the GPV varying from 0 V to 144 V along y = 17.12 mm, y = 17.18 mm, y = 17.24 mm, y = 17.36 mm, y = 17.42 mm, and y = 17.48 mm, respectively, at the TPG open status.

4. Ion mobility spectra for ammonium, DMMP dimer, and acetone dimer, respectively.

As shown in Figure S-4, ammonia, acetone and DMMP all form one ion peak in their spectra. Ammonia has a drift time of 4.13 ms. Acetone goes slower, it appears at 5.67 ms. DMMP goes slowest, it appears at 7.53 ms. The reduced ion mobility for these three ion peaks is calculated to be 2.60, 1.89, and 1.42 $cm^2V^{-1}s^{-1}$, respectively. Accordingly, the three ion peaks are assigned as ammonia ions, acetone dimer ions, and DMMP dimer ions, respectively.

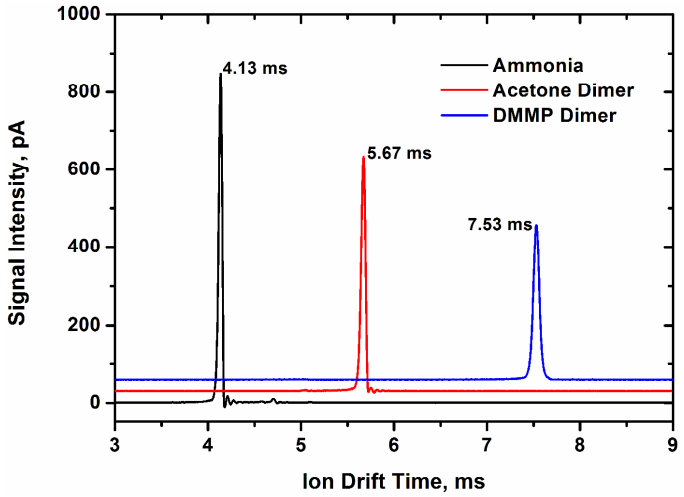

Figure S-4. Ion mobility spectra obtained when ammonium, DMMP, and acetone of high concentration (> 20 ppm) were introduced to the ^{63}Ni source, respectively.

5. Explanation of the resolving power improvement effect of the GPV.

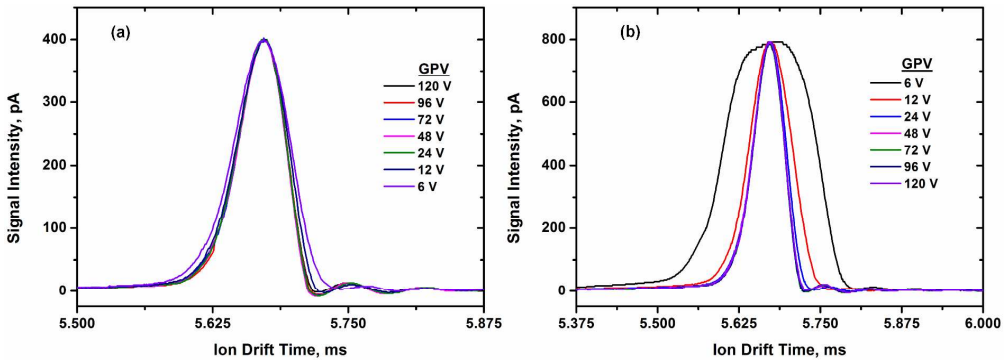

Figure S-5. Ion mobility spectra obtained as varying the GPV from 6 V to 120 V when the acetone dimer peak was kept at 400 pA and 800 pA, respectively. The ^{63}Ni source was doped with acetone (>20 ppm).

Table S-1. Information for the ion peaks shown in Figure S-5a.

GPV (V)	GPW (μs)	GPT (μs)	Effective GPW (μs)	Peak Area (pA×ms)	FWHM (μs)	Resolving Power
6	156.50	105.10	51.40	26.7	59.4	95.5
12	127.50	90.66	36.84	23.9	54.0	105.0
24	88.50	69.14	19.36	22.5	51.5	110.1
48	60.95	43.54	17.41	21.9	50.7	111.8
72	46.80	31.92	14.88	21.8	50.0	113.4
96	38.70	23.81	14.85	21.8	49.8	113.9
120	32.50	17.57	14.83	21.8	49.7	114.1

Table S-2. Information for the ion peaks shown in Figure S-5b.

GPV (V)	GPW (μs)	GPT (μs)	Effective GPW (μs)	Peak Area (pA×ms)	FWHM (μs)	Resolving Power
6	277.50	105.10	172.40	129.4	132.0	42.9
12	165.40	90.66	74.74	66.0	71.5	79.3
24	113.50	69.14	44.36	50.8	57.8	98.1
48	79.95	43.54	36.41	47.3	55.7	101.8
72	63.50	31.92	31.58	46.3	54.5	104.1
96	55.40	23.81	31.55	46.3	53.7	105.6
120	49.10	17.57	31.53	46.3	53.3	106.4

6. The relationship between the TPG ion transmission efficiency and the GPV.

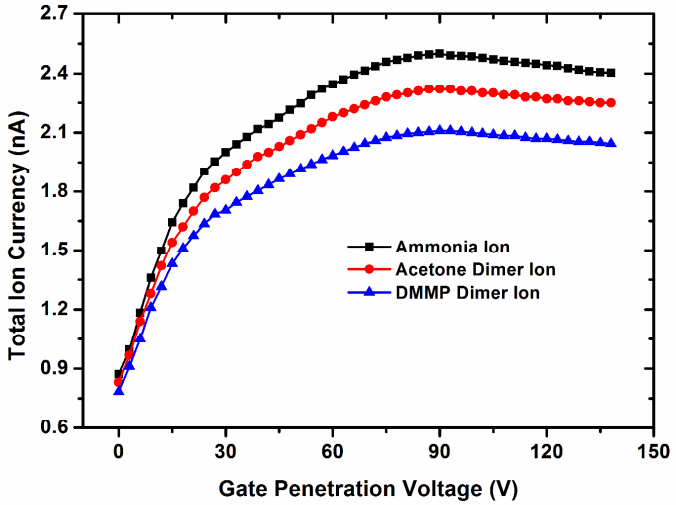

Figure S-6. Plots of the total ion current (TIC) as a function of the GPV when the ^{63}Ni source was doped with ammonium, DMMP, and acetone of high concentration (> 20 ppm), respectively. The TIC was measured with the TPG fully open.