Supplementary Materials for

Electrochemical Oxidative Rearrangement of Tetrahydro-β-carbolines in Zero-gap Flow Cell

Yiting Zheng#^[a][c], Yuen Tsz Cheung#^[b], Lixin Liang^[b], Huiying Qiu^[b], Lei Zhang^[c], Anson Tsang^[a], Qing Chen^[a][b] & Rongbiao Tong^[b]

*Corresponding author. Email: chengqing@ust.hk; rtong@ust.hk;

Index of Supplementary Materials

General Information ................................................................................................................................................. 2

1. Faradaic Efficiency and Productivity ................................................................................................................. 4

2. Flow cell set-up .................................................................................................................................................. 4

3. Other conditions screened .................................................................................................................................. 6

4. Electro-chemical test (undivided cell) ................................................................................................................. 8

5. Electro-chemical test (flow cell) ......................................................................................................................... 9

6. Comparison with literature data ......................................................................................................................... 9

7. Preparation of indole substrates ....................................................................................................................... 13

8. Electrochemical oxidative rearrangement of indoles to 2-oxindoles .................................................................. 16

9. Mechanistic study ............................................................................................................................................. 22

10. References ....................................................................................................................................................... 26

11. Copies of 1H- and 13C-NMR spectra (S28-S85) ............................................................................................ 28
General Information

All the electrochemical experiments and synthesis were carried on electrochemical workstation VMP-300 (as Figure S1A present). Reactions in a flow cell were carried on the two PEEK housing zero-gap membrane reactor with PTFE gasket and celgard 3501, the detail information could be found in section Flow cell set-up in this file. The inlet and outlet injectors were connected to PEEK housing with SMC stainless steel air-tight connector and PTFE tube. The reaction solutions were sealed in bottle with holes, as Figure S1B present, and bumped through the PTFE tube connected with PharMed BPT tube by LongerPump BT-600-2J with YZ1515x in 5-20 mL/min.

Figure S1. (A) Electrochemical workstation VMP-300; (B) Sealed bottle with holes connect with PTFE tubes connect with zero-gap flow cell.

Solvents used in workup, extraction and column chromatography were used as received from commercial suppliers without prior purification. Reactions for substrate preparation were magnetically stirred and monitored by thin layer chromatography (TLC, 0.25 mm) on pre-coated silica gel plates. Flash chromatography was performed with silica gel 60 (particle size 0.040 – 0.062 mm). $^1$H and $^{13}$C NMR spectra were recorded on a Bruker AV-400 spectrometer (400 MHz for $^1$H, 100 MHz for $^{13}$C). Chemical shifts are reported in parts per million (ppm) as values relative to the internal chloroform (7.26 ppm for $^1$H NMR and 77.16 ppm for $^{13}$C NMR). Abbreviations for signal coupling are as follows: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet; br, broad. High resolution mass spectra were measured at the Hong Kong University of Science and Technology Mass Spectrometry Service.
Center on an Agilent GC/MS. Carbon paper (CP, SGL-39AA) and organic deposition on CP after the synthesis mediated by KBr were characterized on the scanning electron microscopy (SEM) (JEOL-7100, 10 kV).

**General Procedure A (using flow cell, Figure S2A) of Electrochemical oxidative rearrangement of indoles to 2-oxindoles:** Reactions were conducted in two 20 mL vials with anolyte and catholyte. The assemble and detail information were discussed in **Flow cell setup.** The reaction was performed in the two PEEK housing flow cell at constant voltage 1.2 V using potentiostatatic method in VMP-300. Anolyte solution of 1a (0.2 mmol) in MeCN/AcOH/H₂O (15:2.4:2, 10 mL) was added bromide salt (0.4 mmol, 2.0 equiv.). The anolyte was separated from the cathode electrolyte in H₂SO₄ (0.25M, 10 mL) by a proton-exchange membrane Nafion 117. The 20 mL/min was set for synthesis, and the cut-off charge was set 2 F/mol. Reaction was monitored by TLC. The reaction mixture was diluted with EtOAc (10 mL). Saturated aqueous Na₂CO₃ solution (10 mL) was added. The organic fraction was collected, and the aqueous fraction was extracted with EtOAc (2 x 10 mL). The combined organic fraction was washed with brine, dried over Na₂SO₄, filtered and concentrated under reduced pressure. The resulting residue was purified by flash column chromatography on silica gel using hexane/ethyl acetate eluents.

![Chemical structures](image)

**Figure S2.** (A) Flow cell using in General Procedure A; (B) Set-up of undivided cell using in General Procedure B
General Procedure B (using undivided cell, Figure S2B) of Electrochemical oxidative rearrangement of indoles to 2-oxindoles: Reactions were conducted in a 20 mL vial with a stir bar and a carbon paper (10 mm*10 mm*0.6 mm) working electrode (anode), a platinum-plated (10 mm*10 mm*0.1 mm) counter-electrode (cathode) and Ag/AgBr reference electrode. Constant voltage mode with 2.0 V was applied by VMP-300. The Ag/AgBr electrode was made by Ag wire and HBr, the potential was calibrated with SCE and convert to -0.26 V vs. RHE. To a solution of 1 (0.1 mmol) in MeCN/AcOH/H2O (15:2.4:2, 10 mL) was added KBr (0.05 mmol, 0.5 equiv.). The resistance in the set-up was measured 122 ohm by VMP-300. Reaction was monitored by TLC and stopped after complete conversion of 1a. The reaction mixture was diluted with EtOAc (10 mL). Saturated Na2CO3 solution (10 mL) was added. The organic fraction was collected, and the aqueous fraction was extracted with EtOAc (2 x 10 mL). The combined organic fraction was washed with brine, dried over Na2SO4, filtered and concentrated under reduced pressure. The resulting residue was purified by flash column chromatography on silica gel using hexane/ethyl acetate eluents.

1. Faradaic Efficiency and Productivity

The faradaic efficiency (FE) of product formation and productivity were calculated using the following equation\(^{1,2}\):

\[
Faradaic \ efficiency(\%) = \frac{n \times F \times mole \ of \ product \ formed}{total \ charge \ passed} \times 100\%
\]

Equation (1)

\[
productivity(\mu mol/ (h \times cm^2)) = \frac{mole \ of \ product \ formed}{total \ time \times electrode \ area}
\]

Equation (2)

where n is the number of electron transfer for each product formation and F is the Faraday constant (96485 C mol\(^{-1}\)). Total time is the time achieved 100% conversion of substrate. Electrode area is the anode geometric area.

2. Flow cell set-up

2.1 Materials for zero-gap flow cell set-up using in General Procedure A:

2 x PEEK endplates (40 mm*40 mm*10 mm) with snake shape of flow channel, as Figure S3A&B shown
4 x PTFE Gasket (40 mm*40 mm*0.3 mm) with a hollow part (10 mm*10 mm) in the middle, as Figure S3C shown

2 x Celgard 3501 (12 mm*12 mm), pretreatment with MeCN

1 x Proton-exchange membrane Nafion® 117 (12 mm*12 mm, pre-treatment with MeCN)

Anode: 2 x Carbon papers (CP, SGL 39AA) (10 mm*10 mm*0.3 mm), heat treatment in 400 °C in air, 24 h

Cathode: 1 x 20% Pt/graphite carbon paper (10 mm*10 mm*0.3 mm), prepared by dripping 20% Pt/graphite (purchase from Sigma-Aldrich) Nafion® solution (5 wt% Nafion amount) on heat treated CP

Current Collector: 2 x Platinum foil (3 mm*25 mm*0.1 mm)

8 x Screws and Screw caps

4 x SMC stainless steel air-tight connectors (tube: 1/8 to M5)

3 x PTFE tube (1/8)

Figure S3. (A) PEEK endplates with flow channels, contact with PTFE gasket and electrode; (B) PEEK endplates with M5 holes connect with SMC air-tight connectors; (C) PTFE gasket with holes and CP in the hole.
2.2 Procedure for flow cell assembly:

![Flow Cell Assembly Diagram]

**Figure S4.** (A) Schematic of flow cell using in General Procedure A; (B) Torque wrench using to tight screw

A PEEK endplate with flow channel facing top was equipped with eight screws. The assemble schematic was presented in Figure S4A. A piece of PTFE gasket was placed on top of the endplate. Two pieces of carbon papers in the middle were fitted in the hollow part of the gasket. Current collector was placed beyond the edge of the set-up. A piece of celgard 3501 was placed on top covering the whole carbon paper electrode. Then additional two pieces of PTFE Gasket with a proton-exchange membrane Nafion 117 in the middle were placed on top. Another piece of celgard 3501 was placed to cover the hollow part. The 20% Pt/graphite CP and current collector were then placed, covered by the last PTFE Gasket and another PEEK endplates and tightened the screws with screw caps using torque wrench, as Figure S4B presented, with uniform force to prevent the deformation and leakage of using PTFE gasket. Finally, four SMC stainless steel air-tight connectors were screwed on two sides of the flow cell with Teflon tape to prevent corrosion and connected with four PTFE tube at the other end.

3. Other conditions screened

| Condition | Details |
|-----------|---------|
| pH | 4-6 |
| Current Density | 0.1-1 A/cm² |
| Flow Rate | 1-2 mL/min |
| Temperature | 20-30 °C |

Table S1. Selected conditions for Br mediated electro-oxidative rearrangement[^a]
| Entry | Different from base case<sup>a</sup> | Current density (mA*cm<sup>-2</sup>) | Conv. (%) | Yield (%) | Faradaic Efficiency (%) | Productivity (μmol*h<sup>-1</sup>*cm<sup>-2</sup>) |
|-------|----------------------------------|------------------------------------|-----------|-----------|------------------------|----------------------------------|
| S1    | NaBr                              | 5.2                                | 100       | 82        | 82                     | 78.7                             |
|       | 40 mL*min<sup>-1</sup>            |                                    |           |           |                        |                                  |
| S2    | KBr 40                            | 3.5                                | 100       | 75        | 75                     | 48.5                             |
|       | mL*min<sup>-1</sup>               |                                    |           |           |                        |                                  |
| S3    | TBAB                              | 1.4                                | 100       | 58        | 58                     | 14.7                             |
|       | 40 mL*min<sup>-1</sup>            |                                    |           |           |                        |                                  |
| S4    | LiBr 5 eq                         | 7.0                                | 100       | 87        | 87                     | 113.6                            |
| S5    | LiBr 2.5 eq                       | 4.4                                | 100       | 95        | 95                     | 82.2                             |
| S6    | LiBr 1.5 eq                       | 2.0                                | 100       | 73        | 73                     | 37.2                             |
| S7    | 40 mL*min<sup>-1</sup>            | 6.4                                | 100       | 96        | 96                     | 114.7                            |
| S8    | 5 mL*min<sup>-1</sup>             | 2.0                                | 100       | 89        | 89                     | 33.2                             |

<sup>a</sup> The reaction was carried out at room temperature with 1α (0.2 mmol), LiBr (2.0 eq), solvents (20 mL) followed general procedure A. NMR yield was obtained.
4. Electro-chemical test (undivided cell)

**Figure S5.** (A) Influence of KBr concentration in General Procedure B; (B) Influence of AcOH addition in General Procedure B
5. Electro-chemical test (flow cell)

![Electro-chemical test (flow cell)](image)

**Figure S6.** (A) LSV of half-flow cell (as photo present) with condition: Working electrode: CP; Counter electrode: Pt mesh; Reference electrode: Ag/AgCl, the $E_{RHE} = E + 0.0591 \times pH + 0.197^{[3]}$; Scan rate 50 mV/s with 0.8 M LiClO$_4$ as supporting electrolyte, 0.2 mmol THβC, 2 e.q. LiBr or KBr; (B) LSV of different flow rate under General Procedure A. (C) Current density in different equivalent of LiBr under General procedure A.

6. Comparison with literature data

We also compared our results with other electrochemical oxidation reactions, in particular, of indole or related N-heterocycle compounds$^{[4-9]}$ in Tables S2-3, which including: (a) electrochemical 1,2-diarylation$^{[4]}$ of alkenes with a CoCl$_2$ catalyst; (b) electrochemical diazidation$^{[5]}$ reaction of alkenes with the MnBr$_2$ catalyst; (c) electro-oxidative [3+2] annulation$^{[6]}$ of phenol and indole; (d) electrochemical radical cascade cyclization$^{[7]}$ of N-methacryloyl-2-phenylbenzoimidazole and alkyl
boronic acid; (e) electrochemical flow microreactor\textsuperscript{[8]} for efficient synthesis of isoquinoline-6(5H)-ones; and (f) flow Rhodaelectro-catalyzed alkyne annulations\textsuperscript{[9]}. The comparison was based on terms of the yield and productivity, i.e., the number of mole of the desired product per unit of reaction time and per area of the cell [in μmol/(h*cm\textsuperscript{2})]. The higher productivity, the shorter time and the smaller cell required, the more cost-effective. As shown in Figure S7, the yield (2p, 94%) of our reaction system was among the best, while the productivity (2p, 144 μmol/(h*cm\textsuperscript{2})) (also see Table S3 in Supporting Information) was much higher than all other electrochemical reactions. We attributed our outstanding performance to the following two factors: 1) the zero-gap flow cell minimizes the overpotential and mitigates the trade-off between a high current and a high selectivity, which is typically encountered in a cell with less forced convection; and 2) the use of bifunctional mediator LiBr with a suitable oxidation potential leaves a sufficiently wide potential window for the high selectivity.

**Figure S7.** Comparison of productivity, Faradaic efficiencies and yield cycle life (Noted: all selected electro-oxidation of indole or N-heterocyclic compounds for a fair comparison, Table S3 summarizes the detail calculation; red bond represents new generated bond during the electrochemical reaction)\textsuperscript{[4–9]}
Table S2. Summary of the detailed reactions in Figure S7 in the article.

| Reaction | Equation | Conditions | Products |
|----------|----------|------------|----------|
| a        | \[
\text{MeO} - \text{C} = \text{H} + 2 \text{MeN} - \text{H}
\] | C(+)/Pt(-) (I = 10 mA), CoCl\(_2\) (10 mol%), NaSO\(_4\)CF\(_3\) (0.04 M), \(n\)Bu\(_4\)Ni (0.1 M), MeCN, rt, 5 h | \[
\begin{align*}
\text{MeO} - \text{NMe} - \text{Me} & \quad \text{MeO} - \text{NMe} - \text{Me} \\
\text{MeN} & \quad \text{MeN}
\end{align*}
\] |
| b        | \[
\text{Ts} - \text{N} + \text{NaN}_3
\] | \(E_{\text{cell}} = 2.3\) V, LiClO\(_4\) (0.1 M), AcOH/MeOH, MnBr\(_2\)·4H\(_2\)O (5 mol%), r.t., argon, undivided cell | \[
\begin{align*}
\text{MeO} - \text{N}_3 & \\
\text{Ts}
\end{align*}
\] |
| c        | \[
\text{MeO} - \text{H} + \text{MeN} - \text{Ac}
\] | C(+)/Pt(-) (I = 10 mA), \(n\)Bu\(_4\)NBF\(_4\) (0.02 M), HFIP/CH\(_2\)Cl\(_2\) (6:4), rt, 1.8 h, undivided cell | \[
\begin{align*}
\text{MeO} - \text{O} & \\
\text{MeN} - \text{Ac}
\end{align*}
\] |
| d        | \[
\text{N} - \text{Me} + \text{B(OH)}_2
\] | C(+)/Ni(-), \(0.1\) mL/min | \[
\begin{align*}
\text{N} - \text{Me} & \\
\text{B(OH)}_2
\end{align*}
\] |
| e        | \[
\text{BnNMe}_2\text{OH} (2\text{ equiv.}) + \text{TEMPO} (1.5\text{ equiv.})
\] | 3 F/mol, 85°C, 2.8 bar, 0.1 mL/min, BPR | \[
\begin{align*}
\text{N} - \text{R} & \\
\text{R}'
\end{align*}
\] |
| f        | \[
\text{O} - \text{Me} + \text{n-Bu} - \text{H}
\] | C(+)/Ni(-), [Cp*RhCl\(_2\)]\(_2\) (2.5 mol%), HOPiv (10 mol%), NaOPiv (2 equiv.), MeOH, rt, O\(_2\), 18-22 h, CPE at 1.5 V | \[
\begin{align*}
\text{O} - \text{Me} & \\
\text{R}
\end{align*}
\] |
**Table S3.** Summary of productivity, Faradaic efficiency and yield in Figure S7

| Entry | Reaction cell          | Electrode | Yield. (%) | Faradaic Efficiency (%) | Productivity (μmol*h⁻¹*cm⁻²) |
|-------|------------------------|-----------|------------|-------------------------|-------------------------------|
| Our work | Divided zero-gap flow cell | CP/Pt C   | 94         | 93                      | 144                           |
| a[^4]  | Undivided beaker       | CC[^a]/Pt | 93         | 64                      | 40                       |
| b[^5]  | Undivided beaker       | RVC[^b]/Pt | 69         | 62                      | 49                       |
| c[^6]  | Undivided beaker       | GR[^c]/Pt | 99         | 60                      | 37                       |
| d[^7]  | Undivided beaker       | CF[^d]/Ni foam | 75     | 54                      | 50                       |
| e[^8]  | Single-pass flow       | Pt/Pt     | 91         | 67                      | 8                         |
| f[^9]  | Undivided flow cell    | GF[^d]/Ni foam | 99     | 27                      | 25                       |

[^a]Carbon Cloth;[^b]Reticulated Vitreous Carbon;[^c]Graphite Rod;[^d]Carbon Felt
7. Preparation of indole substrates

Substrates 1a\textsuperscript{[10]}, 1b\textsuperscript{[11]}, 1c\textsuperscript{[12]}, 1d\textsuperscript{[13]}, 1f-1h\textsuperscript{[14]}, 1i-1j\textsuperscript{[15]}, 1l\textsuperscript{[16]}, 1m\textsuperscript{[17]}, 1n\textsuperscript{[18]}, 1p\textsuperscript{[19]}, 1q\textsuperscript{[17]}, 1r\textsuperscript{[20]}, and 1t\textsuperscript{[17]} were prepared according to the published procedures.

1. Preparation of 1e

To a solution of S1 (516 mg, 3.0 mmol) and Et\textsubscript{3}N (1.25 mL, 9.0 mmol) in CH\textsubscript{2}Cl\textsubscript{2} (3 mL) was added allyl bromide (0.31 mL, 3.6 mmol) at 0 \degree C. The reaction mixture was stirred at rt for 2 h. Saturated NaHCO\textsubscript{3} (10mL) solution was added and extracted with CH\textsubscript{2}Cl\textsubscript{2} (3 x 10 mL). The combined organic fraction was washed with brine, dried over Na\textsubscript{2}SO\textsubscript{4}, filtered, and concentrated under reduced pressure. The resulting residue was purified by flash column chromatography (hexane : EtOAc = 4 : 1) to give compound 1e as a yellow solid (334 mg, 52%). \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) \(\delta\) 7.92 (s, 1H), 7.48 (d, J = 7.0 Hz, 1H), 7.27 (d, J = 6.8 Hz, 1H), 7.21 – 7.04 (m, 2H), 6.07 – 5.88 (m, 1H), 5.39 – 5.15 (m, 2H), 3.62 (s, 2H), 3.25 (d, J = 5.6 Hz, 2H), 2.97 – 2.74 (m, 4H). \textsuperscript{13}C\{\textsuperscript{1}H\} NMR (100 MHz, CDCl\textsubscript{3}) \(\delta\) 136.2, 135.4, 131.8, 127.3, 121.4, 119.4, 118.3, 118.1, 110.8, 108.4, 60.9, 50.8, 50.2, 21.3. HRMS (ESI) \textit{m/z}: Calcd for C\textsubscript{14}H\textsubscript{17}N\textsubscript{2}\textsuperscript{+} [M+H]\textsuperscript{+} 213.1386; Found 213.1383.

2. Preparation of 1k

To a solution of S1 (516 mg, 3.0 mmol) and Et\textsubscript{3}N (1.25 mL, 9.0 mmol) in CH\textsubscript{2}Cl\textsubscript{2} (3 mL) was added allyl bromide (0.31 mL, 3.6 mmol) at 0 \degree C. The reaction mixture was stirred at rt for 2 h. Saturated NaHCO\textsubscript{3} (10mL) solution was added and extracted with CH\textsubscript{2}Cl\textsubscript{2} (3 x 10 mL). The combined organic fraction was washed with brine, dried over Na\textsubscript{2}SO\textsubscript{4}, filtered, and concentrated under reduced pressure. The resulting residue was purified by flash column chromatography (hexane : EtOAc = 4 : 1) to give compound 1e as a yellow solid (334 mg, 52%).
To a solution of S3 (418 mg, 3.6 mmol) and TFA (0.53 mL, 6.9 mmol) in CH₂Cl₂ (10 mL) was added S2 (0.39 mL, 3.0 mmol) at 0 °C and stirred at this temperature for 2 h. Diluted with water (10 mL) and extracted with CH₂Cl₂ (3 x 10 mL). The combined organic fraction was washed with saturated NaHCO₃ solution, brine, dried over Na₂SO₄, filtered, and concentrated under reduced pressure. The resulting residue was directly used in the next step without further purification.

To a solution of crude S4 (269 mg) in THF (5 mL) at 0 °C was added LAH (280 mg, 7.4 mmol) portion wise and stirred for 18 h. Then, diluted with Et₂O (5 mL). Saturated sodium potassium tartrate solution (10 mL) was added and stirred for another 2 h. The resulting mixture was extracted with EtOAc (3 x 10 mL). The combined organic fraction was acidified to pH 1-2 by addition of 1 M HCl. The collected aqueous fraction was then basified to pH 9-10 by addition of 3 N of NaOH. Extracted with EtOAc (3 x 10 mL). The combined organic fraction was washed with brine, dried over reduced pressure. The resulting residue was directly used in the next step without further purification.

To a solution of crude S5 (161 mg) and paraformaldehyde (25 mg, 0.85 mmol) in AcOH (8.5 mL) was heated at at 80 °C for 1 h. After cooling down to rt, the reaction mixture was basified to pH 9-10 by addition of saturated Na₂CO₃ solution and diluted with CH₂Cl₂. Boc₂O (0.23 mL, 1.0 mmol) was added and stirred for another 3 h. The reaction mixture was extracted with CH₂Cl₂ (2 x 10 mL). The combined organic fraction was washed with brine, dried over Na₂SO₄, filtered, and concentrated under reduced pressure. The resulting residue was purified by flash column chromatography (hexane : EtOAc = 12 : 1) to give compound 1k as a white solid (105 mg, 12%). ¹H NMR (400 MHz, CDCl₃) δ 8.28 – 7.97 (m, 1H), 7.10 (d, J = 7.8 Hz, 1H), 7.03 (t, J = 7.8 Hz, 1H), 6.64 (d, J = 7.7 Hz, 1H), 4.64 (br, 2H), 3.95 (s, 3H), 3.76 (br, 2H), 2.79 (br, 2H), 1.51 (s, 9H). ¹³C{¹H} NMR (100 MHz, CDCl₃) δ 155.3, 146.0, 130.4, 128.4, 126.4, 120.1, 111.0, 109.7, 109.2, 102.2, 80.1, 55.5, 42.7, 41.8, 28.6, 21.6. HRMS (ESI) m/z: Calcd for C₁₇H₂₂N₂O₃Na⁺ [M+Na⁺] 325.1523; Found 325.1525.

3. Preparation of 1n

To a solution of S7 (877 mg, 3.0 mmol) in a mixture of saturated NaHCO₃ solution/CH₂Cl₂ (1:4) (25 mL) was added Boc₂O (0.83 mL, 3.6 mmol) and stirred for 3 h. The reaction mixture was extracted with CH₂Cl₂ (2 x 30 mL). The combined organic fraction was washed with brine, dried over Na₂SO₄, filtered, and concentrated under reduced pressure. The resulting residue was purified by flash column
chromatography (hexane : EtOAc = 12 : 1) to give compound 1n as pale-yellow oil (913 mg, 78%). 1H NMR (400 MHz, CDCl₃) δ 8.79 – 8.48 (m, 1H), 7.60 (d, J = 7.6 Hz, 1H), 7.54 – 7.30 (m, 6H), 7.30 – 7.23 (m, 1H), 7.20 (t, J = 7.3 Hz, 1H), 5.70 – 5.29 (m, 1H), 4.79 – 4.40 (m, 3H), 3.92 (s, 1H), 3.75 (s, 1H), 3.33 – 3.05 (m, 1H), 2.98 – 2.87 (m, 1H), 2.87 – 2.76 (m, 1H), 1.75 – 1.53 (m, 9H). 13C{1H} NMR (100 MHz, CDCl₃) δ 154.7, 137.8, 136.1, 132.8, 128.5, 127.8, 126.9, 126.5, 121.7, 119.3, 118.1, 111.0, 108.8, 80.2, 73.5, 71.3, 50.7, 50.0, 40.4, 39.2, 28.5, 21.5. HRMS (ESI) m/z: Calcd for C24H28N2O3Na+ [M+Na]+ 415.1992; Found 415.1994.

4. Preparation of 1s

To a solution of S8 (322 mg, 2.0 mmol) in AcOH (7 mL) was added isobutyraldehyde (0.18 mL, 2.0 mmol) and heated at reflux for 5 h. After cooling down to rt, the reaction mixture was basified to pH 9-10 by addition of saturated Na₂CO₃ solution and diluted with CH₂Cl₂. The reaction mixture was extracted with CH₂Cl₂ (2 x 20 mL). The combined organic fraction was washed with brine, dried over Na₂SO₄, filtered, and concentrated under reduced pressure. The resulting residue was purified by flash column chromatography (hexane : EtOAc = 15 : 1) to give compound 1s as white solid (131 mg, 30%). 1H NMR (400 MHz, CDCl₃) δ 7.77 (br, 1H), 7.55 (d, J = 7.6 Hz, 1H), 7.36 (d, J = 7.8 Hz, 1H), 7.21 (t, J = 7.1 Hz, 1H), 7.16 (t, J = 7.2 Hz, 1H), 4.78 – 4.70 (m, 1H), 4.33 (ddd, J = 11.0, 5.4, 1.5 Hz, 1H), 3.80 (td, J = 10.8, 3.7 Hz, 1H), 2.98 (dddd, J = 15.9, 10.6, 5.4, 2.1 Hz, 1H), 2.76 – 2.67 (m, 1H), 2.16 (ddt, J = 13.7, 6.9, 3.3 Hz, 1H), 1.19 (d, J = 6.9 Hz, 3H), 0.91 (d, J = 6.9 Hz, 3H). 13C{1H} NMR (100 MHz, CDCl₃) δ 136.0, 134.4, 127.3, 121.8, 119.7, 118.2, 111.0, 109.4, 104.9, 77.6, 65.0, 32.6, 22.5, 19.1, 16.8, 16.5. HRMS (ESI) m/z: Calcd for C14H16NO- [M-H]- 214.1237; Found 214.1232
8. Electrochemical oxidative rearrangement of indoles to 2-oxindoles

2a was obtained by General Procedure A [54.7 mg, 95% yield, 89.55 μmol/(h*cm⁻²)] and by General Procedure B (23.1 mg, 80% yield). Eluent solvents: CH₂Cl₂/MeOH = 50:1. ¹H NMR (400 MHz, CDCl₃) (presence of rotamers) δ 9.27 – 9.03 (m, 1H), 7.23 (d, J = 7.7 Hz, 1H), 7.17 (br, 1H), 7.04 (t, J = 7.5 Hz, 1H), 6.96 (d, J = 7.7 Hz, 1H), 3.92 – 3.67 (m, 3H), 3.67 – 3.50 (m, 1H), 2.41 (dt, J = 12.6, 8.2 Hz, 1H), 2.07 (br, 2H), 1.57 – 1.40 (m, 9H).

¹³C {¹H} NMR (100 MHz, CDCl₃) δ 180.2, 154.6, 140.3, 133.1, 128.5, 123.0, 122.8, 110.3, 80.0, 54.5, 53.5, 45.4, 35.7, 28.6. HRMS (ESI) m/z: Calcd for C₁₆H₂₀N₂O₃Na [M+Na⁺] 311.1366; Found 311.1375.

2b was obtained by General Procedure A with flow rate of 40 mL/min [41.2 mg, 84% yield, 114.59 μmol/(h*cm⁻²)]. Eluent solvents: CH₂Cl₂/MeOH = 50:1. ¹H NMR (400 MHz, CDCl₃) (presence of rotamers) δ 8.49 – 8.36 (m, 1H), 7.24 (t, J = 7.7 Hz, 1H), 7.17 (d, J = 7.1 Hz, 1H), 7.05 (t, J = 7.5 Hz, 1H), 6.93 (d, J = 7.5 Hz, 1H), 3.97 – 3.57 (m, 7H), 2.48 – 2.38 (m, 1H), 2.18 – 2.04 (m, 1H). ¹³C {¹H} NMR (100 MHz, CDCl₃) δ 179.8, 155.6, 140.2, 132.8, 132.4, 128.7, 123.2, 122.9, 110.2, 54.5, 54.1, 53.4, 52.8, 52.4, 45.8, 45.3, 36.5, 35.6. HRMS (ESI) m/z: Calcd for C₁₃H₁₄N₂O₃Na⁺ [M+Na⁺] 269.0897; Found 269.0905.

2c was obtained by General Procedure A [25.5 mg, 79% yield, 0.1 mmol scale, 45.69 μmol/(h*cm⁻²)]. Eluent solvents: CH₂Cl₂/MeOH = 50:1. ¹H NMR (400 MHz, CDCl₃) (presence of rotamers) δ 8.49 – 8.24 (m, 1H), 7.31 – 7.20 (m, 2H), 7.20 – 7.11 (m, 1H), 7.11 – 7.00 (m, 1H), 7.00 – 6.88 (m, 1H), 4.06 – 3.93 (m, 1H), 3.93 – 3.80 (m, 2H), 3.80 – 3.59 (m, 1H), 2.53 – 2.38 (m, 1H), 2.29 – 2.02 (m, 4H). ¹³C {¹H} NMR (100 MHz, CDCl₃) (presence of rotamers) δ 180.3, 179.2, 169.7, 169.5, 140.5, 140.2, 132.7, 131.8, 128.9, 128.8, 123.3, 123.1, 122.8, 110.4, 110.3, 55.6, 53.7, 53.7, 51.9, 46.8, 45.3, 36.6, 35.3, 22.7, 22.6. HRMS (ESI) m/z: Calcd for C₁₃H₁₄N₂O₃Na⁺ [M+Na⁺] 269.0897; Found 269.0905.
2d was obtained by General Procedure A with 0.4 mmol LiBr [40.4 mg, 71% yield, 63.59 μmol/(h*cm²)] and by General Procedure B (11.5 mg, 41% yield). Eluent solvents: CH₂Cl₂/MeOH = 100:1-30:1. ¹H NMR (400 MHz, CDCl₃) δ 7.70 (br, 1H), 7.49 (d, J = 7.4 Hz, 1H), 7.39 (d, J = 7.2 Hz, 2H), 7.31 (t, J = 7.4 Hz, 2H), 7.26 – 7.21 (m, 1H), 7.19 (td, J = 7.7, 1.2 Hz, 1H), 7.06 (dd, J = 7.5, 0.8 Hz, 1H), 6.84 (d, J = 7.7 Hz, 1H), 3.75 (ABq, 2H, J = 13 Hz), 3.15 (dt, J = 8.4, 3.9 Hz, 1H), 2.92 (d, J = 9.1 Hz, 1H), 2.81 (d, J = 9.1 Hz, 1H), 2.73 (q, J = 8.3 Hz, 1H), 2.42 (ddd, J = 12.4, 8.3, 3.9 Hz, 1H), 2.09 (dt, J = 13.0, 7.8 Hz, 1H). ¹³C{¹H} NMR (100 MHz, CDCl₃) δ 182.0, 139.8, 139.3, 137.0, 128.7, 128.4, 127.8, 127.1, 123.7, 123.1, 109.3, 77.5, 77.2, 76.8, 64.3, 59.8, 54.4, 53.3, 37.3. HRMS (ESI) m/z: Calcd for C₁₈H₁₉N₂O⁺ [M+H]⁺ 279.1492; Found 279.1494.

2e was obtained by General Procedure A with 0.4 mmol LiBr [33.4 mg, 73% yield, 43.58 μmol/(h*cm²)]. Eluent solvents: CH₂Cl₂/MeOH = 100:1-30:1. ¹H NMR (400 MHz, CDCl₃) δ 9.16 (s, 1H), 7.41 (d, J = 7.3 Hz, 1H), 7.19 (td, J = 7.7, 1.2 Hz, 1H), 7.03 (td, J = 7.6, 0.9 Hz, 1H), 6.91 (d, J = 7.7 Hz, 1H), 5.95 (ddt, J = 16.6, 10.2, 6.3 Hz, 1H), 5.29 – 5.17 (m, 1H), 5.15 – 5.05 (m, 1H), 3.32 – 3.17 (m, 2H), 3.08 (ddd, J = 8.9, 7.6, 4.8 Hz, 1H), 2.96 – 2.86 (m, 2H), 2.81 (dd, J = 16.5, 7.7 Hz, 1H), 2.40 (ddd, J = 12.7, 7.8, 4.8 Hz, 1H), 2.09 (dt, J = 12.8, 7.4 Hz, 1H). ¹³C{¹H} NMR (100 MHz, CDCl₃) δ 183.3, 140.3, 136.5, 135.8, 127.8, 123.4, 122.9, 117.1, 109.8, 64.1, 58.6, 54.5, 53.3, 37.4. HRMS (ESI) m/z: Calcd for C₁₄H₁₇N₂O⁺ [M+H]⁺ 229.1335; Found 229.1344.

2f was obtained by General Procedure A [53.5 mg, 89% yield, 39.85 μmol/(h*cm²)] and by General Procedure B (18.9 mg, 63% yield). Eluent solvents: hexane/EtOAc = 5:1. ¹H NMR (400 MHz, CDCl₃) (presence of rotamers) δ 7.30 (t, J = 7.6 Hz, 1H), 7.18 (br, 1H), 7.06 (t, J = 7.4 Hz, 1H), 6.86 (d, J = 7.8 Hz, 1H), 3.88 – 3.63 (m, 3H), 3.62 – 3.47 (m, 1H), 3.22 (s, 3H), 2.46 – 2.33 (m, 1H), 2.00 (br, 1H), 1.55 – 1.38 (m, 9H). ¹³C{¹H} NMR (100 MHz, CDCl₃) (presence of rotamers) δ 177.4, 154.5, 142.9, 132.9, 128.5, 123.1, 122.5, 108.3, 79.9, 54.5, 53.0, 45.3, 35.6, 28.6, 26.5. HRMS (ESI) m/z: Calcd for C₁₇H₂₂N₂O₃Na⁺ [M+Na]⁺ 325.1523; Found 325.1528.
was obtained by General Procedure A [60.2 mg, 80% yield, 41.79 μmol/(h*cm\(^{-2}\))] and by General Procedure B (22.7 mg, 60% yield). Eluent solvents: hexane/EtOAc = 5:1. \(^1\)H NMR (400 MHz, CDCl\(_3\)) (presence of rotamers) δ 7.37 – 7.27 (m, 7H), 7.24 – 7.13 (m, 2H), 7.09 – 6.99 (m, 1H), 6.82 – 6.67 (m, 1H), 5.03 – 4.84 (m, 2H), 3.94 – 3.70 (m, 2H), 3.70 – 3.55 (m, 1H), 2.54 – 2.39 (m, 1H), 2.18 – 2.02 (m, 1H), 1.56 – 1.43 (m, 9H). \(^{13}\)C\(^{1}\)H NMR (100 MHz, CDCl\(_3\)) (presence of rotamers) δ 177.6, 154.6, 142.0, 135.8, 132.9, 129.0, 128.4, 127.9, 127.4, 123.2, 122.7, 109.4, 80.0, 54.6, 54.2, 53.1, 52.1, 45.6, 45.4, 44.0, 36.6, 35.9, 28.7, 28.6. HRMS (ESI) m/z: Calcd for C\(_{23}\)H\(_{26}\)N\(_2\)O\(_3\)Na\(^+\) [M+Na\(^+\)] 401.1836; Found 401.1843.

2h was obtained by General Procedure A [44.6 mg, 67% yield, 25.01 μmol/(h*cm\(^{-2}\))]. Eluent solvents: hexane/EtOAc = 5:1. \(^1\)H NMR (400 MHz, CDCl\(_3\)) (presence of rotamers) δ 7.30 (t, J = 7.6 Hz, 1H), 7.21 (t, J = 8.5 Hz, 1H), 7.11 (t, J = 7.5 Hz, 1H), 7.06 (d, J = 7.8 Hz, 1H), 5.14 (s, 2H), 3.90 – 3.67 (m, 3H), 3.65 – 3.53 (m, 1H), 3.33 (s, 3H), 2.48 – 2.34 (m, 1H), 2.16 – 2.00 (m, 1H), 1.55 – 1.41 (m, 9H). \(^{13}\)C\(^{1}\)H NMR (100 MHz, CDCl\(_3\)) (presence of rotamers) δ 178.7, 178.2, 154.5, 141.3, 141.2, 132.3, 131.6, 128.7, 123.7, 123.7, 122.7, 109.8, 80.0, 71.6, 56.4, 54.8, 54.3, 53.3, 52.3, 45.6, 45.3, 36.8, 36.0, 28.6, 28.6. HRMS (ESI) m/z: Calcd for C\(_{18}\)H\(_{24}\)N\(_2\)O\(_4\)Na\(^+\) [M+Na\(^+\)] 355.1628; Found 355.1632.

2i was obtained by General Procedure A [51.2 mg, 85% yield, 50.75 μmol/(h*cm\(^{-2}\))] and by General Procedure B (17.0 mg, 56% yield). Eluent solvents: hexane/EtOAc = 4:1-2:1. \(^1\)H NMR (400 MHz, CDCl\(_3\)) (presence of rotamers) δ 9.35 – 9.15 (m, 1H), 7.09 – 6.93 (m, 2H), 6.84 (d, J = 7.7 Hz, 1H), 3.91 – 3.67 (m, 3H), 3.66 – 3.51 (m, 1H), 2.46 – 2.35 (m, 1H), 2.31 (s, 3H), 2.06 (br, 1H), 1.58 – 1.39 (m, 9H). \(^{13}\)C\(^{1}\)H NMR (100 MHz, CDCl\(_3\)) (presence of rotamers) δ 180.3, 154.6, 137.8, 133.4, 132.6, 128.8, 123.6, 110.0, 80.0, 54.5, 53.6, 45.4, 35.6, 28.6, 21.3. HRMS (ESI) m/z: Calcd for C\(_{17}\)H\(_{24}\)N\(_2\)O\(_3\)Na\(^+\) [M+Na\(^+\)] 325.1523; Found 325.1527.

2j was obtained by General Procedure A [45.0 mg, 71% yield, 34.44 μmol/(h*cm\(^{-2}\))]. Eluent solvents: hexane/EtOAc = 4:1-2:1. \(^1\)H NMR (400 MHz, CDCl\(_3\)) (presence of rotamers) δ 8.56 – 8.35 (m, 1H), 6.87 – 6.81 (m, 1H), 6.81 – 6.72 (m, 2H), 3.90 – 3.65 (m, 6H), 3.65 – 3.52 (m, 1H), 2.47 – 2.35 (m, 1H), 2.12 – 2.00 (m, 1H), 1.54 – 1.41 (m, 9H). \(^{13}\)C\(^{1}\)H NMR (100 MHz, CDCl\(_3\)) (presence of rotamers) δ 180.0, 179.8, 156.3, 154.6, 134.6, 133.4, 112.8, 112.6, 110.5,
2k was obtained by General Procedure A [13.3 mg, 42% yield, 0.1 mmol scale, 19.59 μmol/(h*cm²)]. Eluent solvents: hexane/EtOAc = 4:1-2:1. 1H NMR (400 MHz, CDCl₃) δ 7.66 – 7.55 (m, 1H), 7.06 – 6.98 (m, 1H), 6.87 – 6.76 (m, 2H), 3.88 (s, 3H), 3.86 – 3.66 (m, 3H), 3.66 – 3.51 (m, 1H), 2.47 – 2.35 (m, 1H), 2.14 – 2.00 (m, 1H), 1.54 – 1.41 (m, 9H). 13C NMR (100 MHz, CDCl₃) δ 178.9, 178.5, 154.6, 144.0, 134.0, 133.5, 128.7, 123.8, 123.7, 115.2, 110.9, 80.0, 55.9, 54.5, 54.1, 54.0, 53.1, 45.5, 45.3, 36.5, 35.7, 28.7, 28.6. HRMS (ESI) m/z: Calcd for C₁₇H₂₂N₂O₄Na⁺ [M+Na⁺] 341.1472; Found 341.1474.

2l was obtained by General Procedure A [32.5 mg, 53% yield, 35.60 μmol/(h*cm²)]. Eluent solvents: hexane/EtOAc = 6:1-2:1. 1H NMR (400 MHz, CDCl₃) δ 9.17 – 8.92 (m, 1H), 7.22 (t, J = 7.6 Hz, 1H), 7.11 (d, J = 7.4 Hz, 1H), 7.03 (t, J = 7.5 Hz, 1H), 6.93 (d, J = 7.7 Hz, 1H), 4.14 – 3.90 (m, 1H), 3.91 – 3.68 (m, 2H), 2.42 (br, 1H), 2.17 – 1.99 (m, 1H), 1.47 (s, 9H), 1.30 (d, J = 6.5 Hz, 3H). 13C NMR (100 MHz, CDCl₃) δ 179.1, 154.5, 140.4, 133.3, 128.4, 123.0, 122.8, 110.0, 79.9, 61.0, 56.8, 44.6, 33.4, 28.6, 16.7. HRMS (ESI) m/z: Calcd for C₁₇H₂₂N₂O₃Na⁺ [M+Na⁺] 325.1523; Found 325.1523.

2l' was obtained by General Procedure A [10.6 mg, 18% yield, 12.09 μmol/(h*cm²)]. Eluent solvents: hexane/EtOAc = 6:1-2:1. 1H NMR (400 MHz, CDCl₃) δ 8.13 (br, 1H), 7.26 – 7.20 (m, 2H), 7.05 (td, J = 7.6, 0.9 Hz, 1H), 6.92 (d, J = 7.6 Hz, 1H), 4.19 – 4.08 (m, 1H), 3.95 (br, 1H), 3.74 – 3.62 (m, 1H), 2.32 (dt, J = 12.6, 8.1 Hz, 1H), 2.07 (br, 1H), 1.49 (s, 9H). 13C NMR (100 MHz, CDCl₃) δ 180.0, 155.1, 140.6, 130.0, 128.5, 125.3, 122.5, 110.1, 59.1, 46.0, 34.0, 28.7, 17.8. HRMS (ESI) m/z: Calcd for C₁₇H₂₂N₂O₃Na⁺ [M+Na⁺] 325.1523; Found 325.1523.

2m was obtained by General Procedure A with 20 mL solvent [29.3 mg, 56% yield, 17.76 μmol/(h*cm²)] and by General Procedure B (<40%). Eluent solvents: hexane/EtOAc = 6:1-2:1. 1H NMR (400 MHz, CDCl₃) δ 9.33 – 9.12 (m, 1H), 7.22 (dd, J = 10.7, 5.4 Hz, 1H), 7.13 – 6.97 (m, 2H), 6.94 (d, J = 7.6 Hz, 1H), 4.19 – 3.61 (m, 3H), 2.62 – 2.34 (m, 1H), 2.08 – 1.97 (m, 1H), 1.86...
(br, 1H), 1.59 – 1.16 (m, 11H), 0.81 (br, 6H). $^{13}$C{$^1$H} NMR (100 MHz, CDCl$_3$) δ 178.8, 154.8, 139.7, 134.8, 128.2, 123.0, 122.6, 110.0, 80.3, 63.7, 55.9, 44.0, 40.3, 34.0, 28.7, 25.2, 23.1, 22.8. HRMS (ESI) m/z: Calcd for C$_{20}$H$_{28}$N$_2$O$_3$Na$^+$ [M+Na]$^+$ 367.1992; Found 367.1998.

$^{2}$m’’ was obtained by General Procedure A with 20 mL solvent [18.4 mg, 27% yield, 8.57 μmol/(h*cm$^{-2}$)]. Eluent solvents: hexane/EtOAc = 6:1-2:1. $^1$H NMR (400 MHz, CDCl$_3$) δ 8.85 (s, 1H), 7.26 – 7.20 (m, 2H), 7.04 (t, J = 7.5 Hz, 1H), 6.94 (d, J = 7.9 Hz, 1H), 4.29 – 3.95 (m, 2H), 3.58 (dt, J = 11.2, 7.4 Hz, 1H), 2.31 (dt, J = 12.4, 8.5 Hz, 1H), 2.06 – 1.95 (m, 1H), 1.75 (br, 1H), 1.50 (s, 10H), 1.35 (br, 1H), 1.00 (br, 1H), 0.83 (d, J = 6.4 Hz, 3H), 0.58 (d, J = 6.3 Hz, 3H). $^{13}$C{$^1$H} NMR (100 MHz, CDCl$_3$) δ 181.1, 155.4, 140.7, 130.1, 128.5, 125.3, 122.3, 110.3, 80.0, 61.2, 45.8, 41.0, 35.9, 31.1, 28.7, 24.7, 23.5, 22.0. HRMS (ESI) m/z: Calcd for C$_{20}$H$_{28}$N$_2$O$_3$Na$^+$ [M+Na]$^+$ 367.1992; Found 367.1997.

$^{2}$n was obtained by General Procedure A [34.1 mg, 43% yield, 15.24 μmol/(h*cm$^{-2}$)]. Eluent solvents: hexane/EtOAc = 6:1-2:1. $^1$H NMR (400 MHz, CDCl$_3$) δ 8.66 – 8.40 (m, 1H), 7.25 – 7.06 (m, 6H), 7.06 – 6.93 (m, 2H), 6.83 (br, 1H), 4.52 – 3.69 (m, 7H), 2.45 (br, 1H), 2.07 (br, 1H), 1.64 – 1.32 (m, 9H). $^{13}$C{$^1$H} NMR (100 MHz, CDCl$_3$) δ 180.7, 155.0, 141.3, 138.1, 129.9, 128.4, 128.3, 127.4, 127.3, 124.9, 122.8, 122.4, 109.9, 80.3, 72.8, 68.6, 64.4, 55.1, 45.3, 34.7, 28.6. HRMS (ESI) m/z: Calcd for C$_{24}$H$_{28}$N$_2$O$_4$Na$^+$ [M+Na]$^+$ 431.1941; Found 431.1943.

$^{2}$n’ was obtained by General Procedure A [16.9 mg, 21% yield, 7.44 μmol/(h*cm$^{-2}$)]. Eluent solvents: hexane/EtOAc = 6:1-2:1. $^1$H NMR (400 MHz, CDCl$_3$) δ 8.34 (br, 1H), 7.32 (d, J = 7.4 Hz, 1H), 7.29 – 7.16 (m, 4H), 7.11 – 6.95 (m, 3H), 6.88 (d, J = 7.7 Hz, 1H), 4.46 – 3.75 (m, 5H), 3.75 – 3.59 (m, 1H), 3.58 – 3.29 (m, 1H), 2.35 – 2.07 (m, 2H), 1.46 (s, 9H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ 180.7, 155.0, 141.3, 138.1, 129.9, 128.4, 128.3, 127.5, 127.3, 124.9, 122.3, 110.1, 80.2, 73.3, 69.5, 62.2, 46.5, 35.2, 28.6. HRMS (ESI) m/z: Calcd for C$_{24}$H$_{28}$N$_2$O$_4$Na$^+$ [M+Na]$^+$ 431.1941; Found 431.1944.
**2o** was obtained by General Procedure A with 20 mL solvent [23.4 mg, 81% yield, 0.1 mmol scale, 48.36 μmol/(h*cm²)]. Eluent solvents: CH₂Cl/MeOH = 100:1. Data of the major isomer: ¹H NMR (400 MHz, CDCl₃) δ 8.39 (s, 1H), 7.71 (d, J = 7.4 Hz, 1H), 7.30 (dt, J = 7.5, 3.8 Hz, 1H), 7.28 – 7.22 (m, 1H), 7.06 – 6.98 (m, 2H), 6.81 (d, J = 7.7 Hz, 1H), 6.68 (td, J = 7.6, 1.0 Hz, 1H), 6.49 (d, J = 7.5 Hz, 1H), 5.25 (s, 1H), 4.17 – 4.07 (m, 1H), 3.85 (ddd, J = 11.7, 9.9, 1.6 Hz, 1H), 3.11 (dt, J = 13.0, 9.8 Hz, 1H), 2.53 (ddd, J = 13.0, 8.1, 1.9 Hz, 1H). ¹³C{¹H} NMR (100 MHz, CDCl₃) δ 178.0, 171.3, 142.1, 139.6, 134.4, 132.0, 129.2, 129.0, 128.4, 123.8, 123.5, 123.1, 122.0, 110.0, 71.0, 54.9, 41.6, 39.8. HRMS (ESI) m/z: Calcd for C₁₈H₁₄N₂O₂Na⁺ [M+Na⁺] 313.0947; Found 313.0951.

**2p** was obtained by General Procedure A with flow rate of 40 mL/min [65.3 mg, 94% yield, 144.21 μmol/(h*cm²)] and by General Procedure B (25.3 mg, 73% yield). Eluent solvents: hexane/EtOAc = 10:1-3:1. Data of the major isomer: ¹H NMR (400 MHz, CDCl₃) (presence of rotamers) δ 8.93 – 8.82 (m, 1H), 7.29 – 7.20 (m, 1H), 7.13 – 7.08 (m, 1H), 7.08 – 7.01 (m, 1H), 6.99 – 6.92 (m, 1H), 4.79 – 4.57 (m, 1H), 3.89 – 3.66 (m, 1H), 2.63 – 2.50 (m, 1H), 2.44 – 2.34 (m, 1H), 1.51 – 1.40 (m, 1H). ¹³C{¹H} NMR (100 MHz, CDCl₃) (presence of rotamers) δ 178.1, 178.0, 172.6, 172.3, 154.4, 153.5, 139.9, 139.9, 133.4, 133.2, 128.8, 123.3, 123.3, 122.6, 110.4, 81.0, 59.2, 58.8, 55.5, 54.9, 53.2, 52.6, 52.5, 52.3, 40.6, 39.7, 28.4. HRMS (ESI) m/z: Calcd for C₁₆H₁₄N₂O₅Na⁺ [M+Na⁺] 369.1421; Found 369.1428.

**2q** was obtained by General Procedure A [12.8 mg, 63% yield, 0.1 mmol scale, 65.68 μmol/(h*cm²)]. Eluent solvents: hexane/EtOAc = 3:1:1:1. ¹H NMR (400 MHz, CDCl₃) δ 8.73 (br, 1H), 7.28 – 7.20 (m, 2H), 7.06 (t, J = 7.3 Hz, 1H), 6.95 (d, J = 7.6 Hz, 1H), 4.30 – 4.12 (m, 3H), 2.70 (ddd, J = 12.7, 9.4, 6.6 Hz, 1H), 2.20 (ddd, J = 10.0, 7.8, 3.7 Hz, 1H), 0.91 (d, J = 6.2 Hz, 3H). ¹³C{¹H} NMR (100 MHz, CDCl₃) δ 180.0, 140.3, 131.8, 128.1, 124.8, 122.8, 110.0, 82.4, 67.3, 58.4, 38.2, 15.2. HRMS (ESI) m/z: Calcd for C₁₂H₁₅NO₂Na⁺ [M+Na⁺] 226.0838; Found 226.0838.
2r was obtained by General Procedure A [32.2 mg, 74% yield, 80.08 μmol/(h*cm\(^{-2}\))]. Eluent solvents: hexane/EtOAc = 3:1-1:1. \(^1\)H NMR (400 MHz, CDCl\(_3\)) δ 8.21 (br, 1H), 7.26 (d, J = 7.4 Hz, 2H), 7.22 (t, J = 7.6 Hz, 1H), 7.03 (t, J = 7.6 Hz, 1H), 6.90 (d, J = 7.7 Hz, 1H), 4.27 (td, J = 8.9, 5.6 Hz, 1H), 4.18 (td, J = 8.7, 6.0 Hz, 1H), 2.67 (ddd, J = 12.8, 9.3, 6.0 Hz, 1H), 2.31 (ddd, J = 12.9, 8.9, 5.4 Hz, 1H), 1.34 (s, 3H), 1.10 (s, 3H). \(^{13}\)C\{\(^1\)H\} NMR (100 MHz, CDCl\(_3\)) δ 179.9, 140.6, 131.8, 128.2, 125.1, 122.5, 109.7, 84.9, 64.5, 60.0, 36.1, 24.4, 23.4. HRMS (ESI) m/z: Calcd for C\(_{13}\)H\(_{15}\)NO\(_2\)Na\(^{+}\) [M+Na\(^+\)] 240.0995; Found 240.0998.

2s was obtained by General Procedure A [31.0 mg, 67% yield, 23.75 μmol/(h*cm\(^{-2}\))]. Eluent solvents: hexane/EtOAc = 3:1-1:1. \(^1\)H NMR (400 MHz, CDCl\(_3\)) δ 8.92 (s, 1H), 7.30 – 7.19 (m, 2H), 7.06 (t, J = 7.5 Hz, 1H), 6.97 (d, J = 7.7 Hz, 1H), 4.24 – 4.09 (m, 2H), 3.73 (d, J = 9.9 Hz, 1H), 2.68 (ddd, J = 12.4, 9.1, 7.6 Hz, 1H), 2.13 (ddd, J = 12.7, 7.8, 5.2 Hz, 1H), 1.59 (ddt, J = 13.2, 10.0, 6.6 Hz, 1H), 1.00 (d, J = 6.5 Hz, 3H), 0.43 (d, J = 6.7 Hz, 3H). \(^{13}\)C\{\(^1\)H\} NMR (100 MHz, CDCl\(_3\)) δ 180.9, 140.2, 132.1, 128.1, 124.8, 122.7, 110.1, 91.6, 66.6, 56.9, 40.6, 30.3, 21.1, 17.6. HRMS (ESI) m/z: Calcd for C\(_{14}\)H\(_{17}\)NO\(_2\)Na\(^{+}\) [M+Na\(^+\)] 254.1151; Found 254.1148.

2t was obtained by General Procedure A [38.5 mg, 71% yield, 46.36 μmol/(h*cm\(^{-2}\))]. Eluent solvents: hexane/EtOAc = 3:1-1:1. \(^1\)H NMR (400 MHz, CDCl\(_3\)) δ 8.62 (s, 1H), 7.29 – 7.21 (m, 2H), 7.06 (td, J = 7.6, 1.0 Hz, 1H), 6.94 (d, J = 7.7 Hz, 1H), 4.23 – 4.08 (m, 2H), 3.81 (d, J = 9.8 Hz, 1H), 2.64 (ddd, J = 12.4, 9.3, 7.5 Hz, 1H), 2.09 (ddd, J = 12.7, 7.8, 5.1 Hz, 1H), 2.03 – 1.96 (m, 1H), 1.69 – 1.60 (m, 1H), 1.52 – 1.43 (m, 1H), 1.43 – 1.29 (m, 2H), 1.14 – 0.96 (m, 3H), 0.90 – 0.81 (m, 1H), 0.81 – 0.71 (m, 2H). \(^{13}\)C\{\(^1\)H\} NMR (100 MHz, CDCl\(_3\)) δ 180.6, 139.9, 132.1, 128.0, 124.7, 122.8, 110.1, 90.1, 66.4, 56.6, 40.6, 39.4, 31.1, 27.4, 26.2, 25.5. HRMS (ESI) m/z: Calcd for C\(_{17}\)H\(_{21}\)NO\(_2\)Na\(^{+}\) [M+Na\(^+\)] 294.1464; Found 294.1465.

9. Mechanistic study

9.1 Isotopic labelling experiment with \(^{18}\)O
Reactions were conducted in two 4 mL vials with anolyte and catholyte. The assemble and detail information were discussed in Flow cell setup. The reaction was performed in the two PEEK housing flow cell at constant voltage 1.2 V using potentiostatatic method in VMP-300. Electrolyte was prepared by the addition of LiBr (0.2 mmol, 2.0 equiv.) in MeCN/AcOH/H$_2^{18}$O (30:5:2, 3 mL). 1a (27.2mg, 0.1 mmol) was added in the anolyte. The anolyte was separated from the cathode electrolyte (3mL) by a proton-exchange membrane Nafion 117. The 20 mL/min was set for synthesis, and the cut-off charge was set 2 F/mol. Reaction was monitored by TLC. The reaction mixture was diluted with EtOAc (10 mL). Saturated aqueous Na$_2$CO$_3$ solution (10 mL) was added. The organic fraction was collected, and the aqueous fraction was extracted with EtOAc (2 x 10 mL). The combined organic fraction was washed with brine, dried over Na$_2$SO$_4$, filtered and concentrated under reduced pressure. The resulting residue was purified by flash column chromatography on silica gel (CH$_2$Cl$_2$/MeOH = 50:1) to give compound 2a (26.9mg, 92.6%). $^1$H NMR (400 MHz, CDCl$_3$) (presence of rotamers) $\delta$ 8.69 – 8.60 (m, 1H), 7.26 - 7.20 (m, 1H), 7.18 (t, J = 9.7 Hz, 1H), 7.05 (t, J = 7.4 Hz, 1H), 6.97 - 6.90 (m, 1H), 3.92 - 3.68 (m, 3H), 3.65 – 3.55 (m, 1H), 2.47 - 2.36 (m, 1H), 2.15 - 2.01 (m, 1H), 1.48 (d, J = 24.1 Hz, 9H). $^{13}$C{$_1$H} NMR (100 MHz, CDCl$_3$) (presence of rotamers) $\delta$ 180.3, 180.0, 154.6, 140.2, 133.2, 128.5, 123.1, 122.9, 110.2, 80.0, 54.5, 54.0, 53.5, 52.5, 45.6, 45.3, 36.5, 35.7, 28.7, 28.6. HRMS (ESI) m/z: Calcd for C$_{16}$H$_{20}$N$_2$O$_3$Na$^+$ [M+Na]$^+$ 313.1409; Found 313.1413. m/z: Calcd for C$_{16}$H$_{20}$N$_2$O$_3$Na$^+$ [M+Na]$^+$ 311.1366; Found 311.1370.

Intensity of peak m/z 313.1413 (C$_{16}$H$_{20}$N$_2$O$_2$/$^{18}$ONa$^+$) : 5.572e6

Intensity of peak m/z 311.1370 (C$_{16}$H$_{20}$N$_2$O$_3$Na$^+$) : 8.255e5

Percentage of $^{18}$O substitution = \[
\frac{5.572e6}{5.572e6+8.255e5} = 87\% 
\]
9.2 RBS trapping

The reaction was conducted following General Procedure A in 0.1 mmol scale with 1.0 equiv. 3 (0.1 mmol) added in anolyte. After workup, the ratio of 2a and 4 was determined by NMR of the crude product. It was found that 2a/4 = 1:0.

The reaction was conducted following General Procedure A in 0.1 mmol scale with 3 instead of 1a added in anolyte. Compound 4 was obtained without further purification (16.9mg, 91%). $^1$H NMR
(400 MHz, CDCl₃) δ 7.42 - 7.34 (m, 2H), 6.82 - 6.75 (m, 2H), 3.78 (s, 3H). ¹³C¹H NMR (100 MHz, CDCl₃) δ 158.8, 132.4, 115.9, 113.0, 55.6. HRMS (Cl) m/z: Calcd for C₇H₇OBr⁺ [M⁺] 185.9675; Found 185.9687.

9.3 Detection of RBS

The fluorescent probe was prepared according to the published literature[21].

![Chemical reaction diagram]

Absorption spectra of fluorescent probe

![Absorption spectra graph]

- HOBr solution
- Probe solution
- HOBr solution with probe
- Reaction mixture with probe
Figure S8. (a) Absorption spectra of fluorescent probe in different solution and HOBr solution. (b). Fluorescent spectra of reaction mixture before and during reaction.

Based on the results from Zeng[21], the shift in both UV absorption and fluorescent emission refer to the presence of HOBr (RBS) in the reaction mixture after connecting to electricity. This can support the in situ generation of HOBr after connecting electricity.

10. References

[1] M. Wang, S. Liu, T. Qian, J. Liu, J. Zhou, H. Ji, J. Xiong, J. Zhong, C. Yan, Nat Commun 2019, 10, 341.
[2] M. J. Kim, Y. Seo, M. A. Cruz, B. J. Wiley, ACS Nano 2019, 13, 6998–7009.
[3] Keiichi. Tsuji, P. J. Elving, Anal. Chem. 1969, 41, 216–218.
[4] J. Qin, M. Luo, D. An, J. Li, Angew. Chem. 2021, 133, 1889–1896.
[5] N. Fu, G. S. Sauer, A. Saha, A. Loo, S. Lin, Science 2017, 357, 575–579.
[6] K. Liu, S. Tang, P. Huang, A. Lei, Nat Commun 2017, 8, 775.
[7] Y. Yuan, Y. Zheng, B. Xu, J. Liao, F. Bu, S. Wang, J.-G. Hu, A. Lei, ACS Catal. 2020, 10, 6676–6681.
[8] A. A. Folgueiras-Amador, K. Philipps, S. Guilbaud, J. Poelakker, T. Wirth, Angew. Chem. Int. Ed. 2017, 56, 15446–15450.
[9] W.-J. Kong, L. H. Finger, A. M. Messinis, R. Kuniyil, J. C. A. Oliveira, L. Ackermann, J. Am. Chem. Soc. 2019, 141, 17198–17206.
[10] M. Géraldy, M. Morgen, P. Sehr, R. R. Steimbach, D. Moi, J. Ridinger, I. Oehme, O. Witt, M. Malz, M. S. Nogueira, O. Koch, N. Gunkel, A. K. Miller, J. Med. Chem. 2019, 62, 4426–4443.
[11] J. Ye, Y. Lin, Q. Liu, D. Xu, F. Wu, B. Liu, Y. Gao, H. Chen, *Org. Lett.* 2018, 20, 5457–5460.
[12] J. Ye, J. Wu, T. Lv, G. Wu, Y. Gao, H. Chen, *Angew. Chem. Int. Ed.* 2017, 56, 14968–14972.
[13] K. Buaban, W. Phutdhawong, T. Taechowisan, W. S. Phutdhawong, *Molecules* 2021, 26, 207.
[14] E. J. Cochrane, L. A. Hassall, I. Coldham, *J. Org. Chem.* 2015, 80, 5964–5969.
[15] N. Jana, Q. Nguyen, T. G. Driver, *J. Org. Chem.* 2014, 79, 2781–2791.
[16] G. Zhao, L. Liang, E. Wang, S. Lou, R. Qi, R. Tong, *Green Chem.* 2021, 23, 2300–2307.
[17] J. Xu, L. Liang, H. Zheng, Y. R. Chi, R. Tong, *Nat Commun* 2019, 10, 4754.
[18] Y.-N. Sun, C.-L. Wang, N. Zhang, Z. Wang, Z.-L. Liu, J.-L. Liu, *Chinese Chemical Letters* 2014, 25, 1503–1506.
[19] L. Chen, J. Xie, H. Song, Y. Liu, Y. Gu, L. Wang, Q. Wang, *J. Agric. Food Chem.* 2016, 64, 6508–6516.
[20] X. Zhang, X. Li, J. C. Lanter, Z. Sui, *Org. Lett.* 2005, 7, 2043–2046.
[21] X. Huo, X. Wang, R. Yang, Z. Li, Y. Sun, L. Qu, H. Zeng, *Sensors and Actuators: B. Chemical.* 2020, 315, 128125.
11. Copies of $^1$H- and $^{13}$C-NMR spectra (S28-S85)
(400MHz, CDCl₃)
NAME: EC-1g
EXPN0: 2
PROCNO: 1
Date: 2021.12.2
Time: 22:14
INSTRUM: spct
PULPROG: 5 mm FASNO, NE/1
PULPROG: exp13VD
TD: 65,536
SOLVENT: CDCl3
NS: 35
DS: 2
SNH: 24048.461 Hz
FIDRES: 0.566796 Hz
AG: 1.2623999 Hz
RG: 196.92
INC: 26.850 ua
DE: 6.90 ua
TKE: 256.7 K
D1: 2.000000 Hz
D1: 0.03000000 Hz
TDD: 1
------ CHANNEL f1 ------
S001: 180.6220298 MHz
NUC1: 13C
P1: 9.70 us
G1: 22760
DF: 100.6127630 MHz
M1: 1,3B
LB: 1,00 Hz
CB: 0
PC: 1,46
$\text{2c}$

$(400\text{MHz, CDCl}_3)$

NAME  FZ-299L-2
EXPNO  6
PRGNO  1
DSPL  20510327
TMS  1.00
INSTRUM  spect
PROBID  5 mm PABBO BB
PULLENG  2000
TD  5530
SOLVENT  CDCl$_3$
NS  16
DS  2
SWH  8012.829 Hz
FIDRES  0.122294 Hz
AQ  4.089466 sec
PG  42.55
DW  62.4900 sec
DG  0.50 ussec
TE  287.4 K
CT  0.00000000 sec
TD0  1

---------- CHANNEL II ----------
SPC1  400.1334710 MHz
NUC1  1H
P  14.50 ussec
SI  695296
SF  400.1334710 MHz
WW  0.00 Hz
SSB  0
LB  0.00 Hz
GB  0
PC  1.00
N-Bn

(400MHz, CDCl₃)
2i
(400MHz, CDCl₃)

NAME  EC-2031201
EXPN   1
PROCNO 1
Date  2021-12-01
Time  20.19
INSTRUM  spect
PROBHD  5 mm PABB5 Bb9
PULPROG  ZG30
TD  65536
SOLVENT  CDCl₃
N1  16
OS  2
SWH  8912.820 Hz
FIDRES  0.125666 Hz
AQ  4.0884666 sec
RG  27.70
DW  0.000 sec
DE  4.50 usec
TE  28.86 cycles
LT  1000.0000000 sec
TD0  1
---------- CHANNEL 11 ----------
SP1  400.1300000000 MHz
NU1  1H
P1  14.50 usec
SI  65536
SP  400.1300000000 MHz
WOW  PM
NSB  0
MB  0.80 Hz
PC  1.00
(100MHz, CDCl₃)
2m
(100MHz, CDCl₃)
$2n'$

(100MHz, CDCl$_3$)
2o
(400MHz, CDCl₃)
2q
(400MHz, CDCl₃)
(400MHz, CDCl₃)
(400MHz, CDCl₃)
(400MHz, CDCl₃)
$\text{NAME} \quad \text{EC-THP]-C}$
$\text{EXPNO} \quad 2$
$\text{Date} \quad 20211216$
$\text{Time} \quad 11.11$
$\text{INSTRUM} \quad \text{Spect}$
$\text{PROBID} \quad 5 \text{mm DML13C-1}$
$\text{POLPROG} \quad 200350$
$\text{T1} \quad 6509$
$\text{SOLVENT} \quad \text{CDCl3}$
$\text{NS} \quad 140$
$\text{SW} \quad 240.38461 \text{ Hz}$
$\text{MSGES} \quad 0.502789 \text{ Hz}$
$\text{AQ} \quad 1.6331998 \text{ sec}$
$\text{RG} \quad 2050$
$\text{DW} \quad 20.000 \text{ ussec}$
$\text{DE} \quad 6.000 \text{ ussec}$
$\text{TE} \quad 24.3 \text{ ms}$
$\text{D1} \quad 0.0000000 \text{ sec}$
$\text{D11} \quad 0.0000000 \text{ sec}$
$\text{TDD} \quad 1$

$\text{<<<<<< CHANNEL 1 >>>>>>}$
$\text{NUC1} \quad 100$
$\text{PL1} \quad 0.00 \text{ ussec}$
$\text{PL1W} \quad 0.00 \text{ ussec}$
$\text{SF01} \quad 100.028229 \text{ MHz}$

$\text{<<<<<< CHANNEL 2 >>>>>>}$
$\text{CPD} \quad \text{walk}$
$\text{NUC2} \quad 1H$
$\text{PG02} \quad 80.00 \text{ ussec}$
$\text{PL2} \quad 1.00 \text{ DB}$
$\text{PL12} \quad 14.39 \text{ DB}$
$\text{RI} \quad 12.00 \text{ ussec}$

$\text{2t}$

$(100 \text{MHz, CDCl}_3)$
(400MHz, CDCl₃)

NAME  FZ-4005-2
EXPNO  3
PROCNO  1
Date_  20220730
Time_  16:38
INSTRUM_ spect
PRBIRD_ 5 mm DUL 10C-1
PULPROG_ zg20
TD_  65536
SOLVENT_ CDCl₃
NS_  16
DS_  2
SWH_  8223.685 Hz
FIDRES_ 0.125393 Hz
AQ_  3.984287 sec
RG_  409
DW_  60.000 usec
DE_  0.00 usec
TE_  292.8 K
D1_  1.000000 sec
TD0_  1

CHANNEL 11

NUC_ 1H
P1_  15.60 usec
PL_  -180.00
PLW_  12.1747940 W
SF/1_  400.1224710 MHz
SI_  32768
SF_  400.1300090 MHz
WDW_  60
SSB_  0
GB_  0.29 Hz
PC_  1.00
MeO
4
(Br)
(400MHz, CDCl₃)
MeO·

(100MHz, CDCl₃)

NAME  WZ-4008-c
EXPNO   3
PROCNO  1
Data    20220714
Time    20.32
INSTRUM spectr.
PROBBD  5 mm FABBO BB/
PULPROG vppp30
TD       65536
SOLVENT CDCl₃
NS       200
dS      200
fMN    24038.461 Hz
FIDRES  0.366798 Hz
AQ     1.3631988 se
RG       196.92
DM      20.800 us
DK      6.500 us
TB       296.3 K
D1       2.0000000 se
D11     0.03000000 se
TD0     1

======== CHANNEL f1 ========
SF01  100.6228298 MHz
NUC1   13C
P1    0.700 us
ST    32768
SF    100.6127145 MHz
NDW   0 MHz
SSB   0
LB    1.00 Hz
GB    0
PC    1.40