



SenCell™ - A New Electrochemical Flow Cell for Sensitive Neurotransmitter Analyses

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INTRODUCTION

The study of neurotransmitter levels in brain remains an analytical challenge, despite significant improvements over the years. Concentrations of some neurotransmitters from particular brain regions are close to the detection limit of current analytical methods, and to increase time resolution there is a demand to measure in ever smaller sample volumes (<5µL). Any improvement that can enhance the detection sensitivity are therefore relevant.

Antec had developed the SenCell™, a new electrochemical flow cell for (U)HPLC with ECD. The SenCell with its optimized confined wall-jet design shows considerable improvements in signal-to-noise characteristics which makes the cell very well suitable for ultra-trace analysis of neurotransmitters in dialysates and brain homogenates. The superior performance and novel functionality of the new SenCell is demonstrated with some examples.



Figure 1. New SenCell electrochemical Flow cell for (U)HPLC-ECD trace analysis. The SenCell can be combined with several different reference electrodes (from left to right): **HyREF** (Pd/H₂), **ISAAC** (In-Situ Ag/AgCl) and **Salt Bridge** (Ag/AgCl) electrode, to ensure compatibility with a wide range of LC conditions & analyses.

FEATURES

The New SenCell has several unique features (Patent pending):

- **Compact Size** (diameter 38 mm, Height 32 mm)
- **Toolless Assembly of Flow Cell** (Easy-lock screw connection)
- **Spacerless Concept** (No cumbersome polymeric/metal spacers required)
- **Stepless Adjustable Working Volume** (Tunable response, high sensitivity, superior S/N ratio)
- **Fast Noise Stabilization**
- **Leak-free up to 25 Bar** (O-ring sealing)
- **Ease of Use and Maintenance**



Figure 2. Exploded view of the New SenCell.

SENCELL VERSUS VT-03

To demonstrate the excellent performance of the new electrochemical flow cell a SenCell with a 2 mm Glassy Carbon working electrode (WE) was compared to an Antec VT-03 flow cell with identical WE diameter and the signal and noise evaluated (see figure 3). The VT-03 was equipped with a 25 µm FEP spacer, the SenCell was set to an optimum spacing of approximately 10 µm which corresponds to a cell working volume of 30 nL.

The SenCell in this example showed:

- Signal factor 1.5 – 2 higher !
- Noise factor 3 lower !

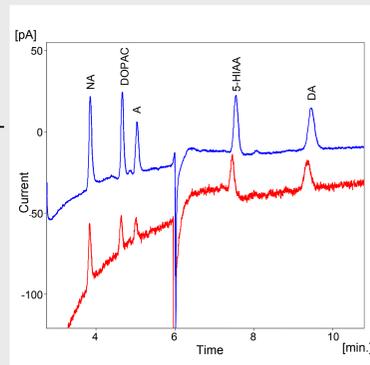


Figure 3. 5 µL injection of a 1 nM mixture of Monoamines and metabolites in 10 mM HAC ringer. Red: Signal of VT-03, Blue: Signal of SenCell.

TUNING OF DETECTION PERFORMANCE

The SenCell design eliminates the use of cumbersome spacers. The working volume of the electrochemical cell can be stepless adjusted without opening the cell by means of a special adjuster tool, allowing easy optimization of the detection sensitivity for any LC application. The spacing between inlet and working electrode can be tuned between roughly 0-100 µm resulting in excellent performance in ultra-trace analysis.

Signal

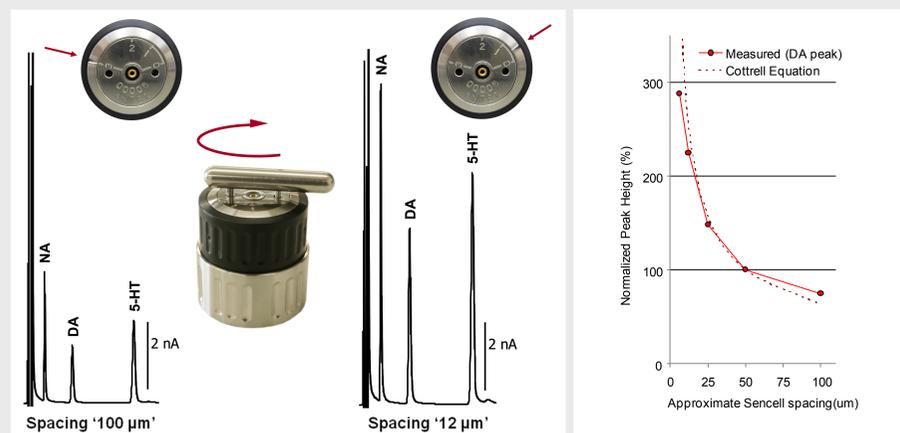
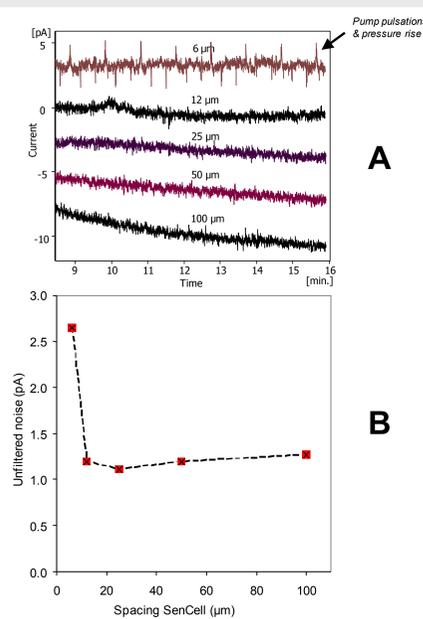


Figure 4. Left side: Chromatograms of 100 nM standard in 10 mM HAC recorded with the Sencell spacing adjustment set to position 3 and 0.5, corresponding with an approximate spacing setting of 100 µm and 12 µm respectively. Right side: Normalized Peak height of Dopamine as a function of spacing setting (red curve) and a simulated curve based on the Cottrell equation. A smaller working volume (spacing) results in a higher response!

Noise



Signal/Noise

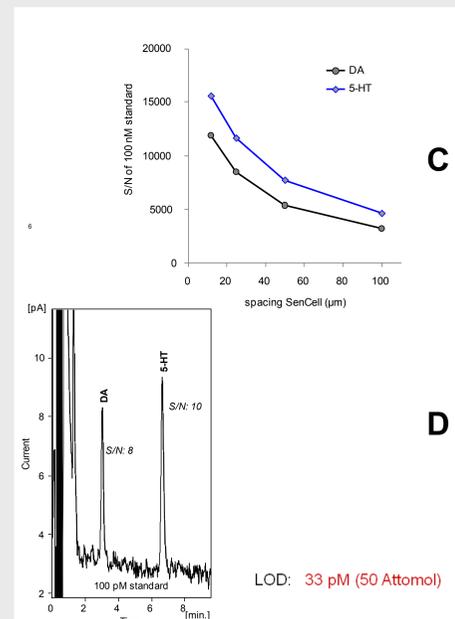


Figure 5. Left side: (A) Noise traces as a function of cell spacing. (B) ASTM noise values as a function of cell spacing. Right side: (C) S/N ratio as a function of cell spacing. (D) Chromatogram: 1.5 µL injection on a 50x0.5 mm ID C18 column of a 100 pM DA & 5-HT standard in 10 mM HAC (Blank subtracted) with the Sencell spacing set to position 0.5 (±12 µm). Noise remains relatively constant over the working volume range, optimizing the working volume results in high S/N ratios!

FAST STABILIZATION

After installation and electrochemical activation (10 minutes pulse form E1=-1V, E2=+1V, t1 and t2 = 1 sec) the SenCell background current stabilizes after a short period of time allowing trace analyses after approximately 4 hours waiting time.

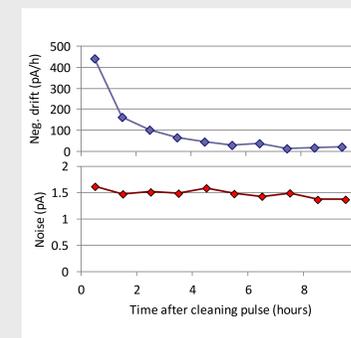


Figure 6. Stabilization profile SenCell. Blue curve: drift (pA/hour). Red curve: noise (pA, unfiltered raw data at 10 Hz).

UHPLC

The SenCell is capable to detect fast temporal responses and is therefore suitable for UHPLC applications.

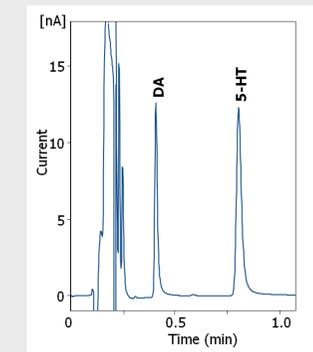


Figure 7. 100 nM DA and 5-HT standard in 10 mM HAC (5 µL full loop injection).

DIALYSATES

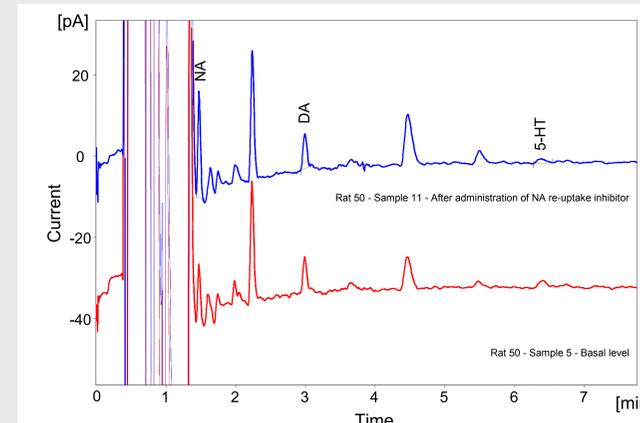


Figure 8. Examples of Dialysate chromatograms (5 µL injections) recorded with the SenCell in combination with the ALEXYS Neurotransmitter analyzer, UHPLC. Blue curve: Dialysate of rat Prefrontal Cortex (PFC), basal level. Red curve: PFC dialysate of same rat after administration of an NA re-uptake inhibitor. Estimated Monoamines concentration in the sample after drug administration: 0.32 nM NA, 0.16 nM DA and 0.05 nM 5-HT. Samples kindly provided by Mrs. Gardien Korte-Bouws, Department of Psychopharmacology, University of Utrecht, The Netherlands

CONCLUSIONS

- The SenCell with its unique compact design combines ease of use (toolless assembly, spacerless) with the ability of stepless tuning of the cell working volume between 0 - 300 nL to optimize the S/N ratio.
- The SenCell under test showed significantly better signal-noise characteristics. Up to factor 4 - 6 improvement in S/N ratio was observed compared to an amperometric flow cell with the same working electrode diameter (VT-03).

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