Roundtable Session 2 – Table 4 – Technology Advancements in CE

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Abstract:

Over the past years, capillary electrophoresis (CE) has seen significant technological advancements, reinforcing its role as a high-resolution, efficient, and versatile analytical tool in pharmaceutical science. Innovations in instrumentation, capillary surface chemistry, and detection methods have expanded CE's capabilities, making it suitable for a wide range of applications from small molecule analysis to complex biologics.

One of the most impactful developments has been the integration of CE with mass spectrometry (CE-MS), enabling simultaneous separation and identification of analytes with high sensitivity and specificity. Advances in capillary coatings—such as dynamic and covalent polymer layers—have improved reproducibility and minimized analyte-wall interactions, enhancing peak resolution and method robustness.

Enhanced detection techniques, including laser-induced fluorescence (LIF) and electrochemical detection, along with refined sample preconcentration strategies, have further improved CE's sensitivity and applicability to trace-level analysis.

Which of these new technologies will find their way into routine testing within the pharmaceutical industry? Which of the latest innovations are already implemented? What are the regulatory expectations regarding CE technology advancements?

Discussion Questions:

1) Which detection methods (optical / MS / conductivity) will become more relevant and also accepted by regulatory authorities?

2) Which critical quality attributes (CQAs) might become widely accessible in the future via CE in an industrial environment, aside from size and charge variants? What will be the regulatory expectation?

3) What will be the impact of automation and high-throughput? Is it necessary/feasible in an industrial context?

4) What will be the impact of new separation media, like chiral media, organic solvents?

Notes:

- General question: How can we improve sensitivity and what applications require improved sensitivity?
    - General response: A lot of current applications do not need sensitivity improvement.
    - Detectors that have flat baselines are requested. Native fluorescence helping with automatic integration.
- General question: How is robustness for instruments when in a GMP settings being considered?
    - Some detectors like MS have higher maintenance than other detectors making it less robust. But there is development in making MS detectors that are more CE applicable and general user friendly, the consensus is to have this keep improving.
    - New technology has been generating new critical reagents and there is uncertainty in the establishing reliable supply chains.
    - There are advantages to having technology that can be used from initial development to GMP QC applications.
    - Technology improvements for peak identification is going but still needed. Linking to MS detectors.
- Multiple capillary technology may not be the best technology for QC or initial method development. But they have a place where throughput is needed so transferring between single channel and multiple channels is needed. Note there is a strong request for having native fluorescence on PA800 and BioPhase from Sciex.
- Technology for DNA sizing is a growing market following WHO and FDA recommendations.
- Preassembled capillaries are seen as an advantage for having robust capillaries need faster development.
- Ideas around Kits vs components. There is a general request to be able to purchase the individual components to be greener and have more flexibility. Kits are good when they work but they make it difficult to development method when they don't work. There is a desire to have the ability to get the individual components from kits to screen options then select the ideal components to establish a kit that is made itself. Response from vendors is that it is expensive to establish such a design.
- Is automated CE possible? The desire is more for the automated detection and processing. It seems like a fantasy to have the sample put into an instrument and that it can be automatically processed and data put into a database.