Orthogonal, Microfluidic Size- and Charge-based Fractionation of Polymer Microparticles

Sergio Fernández-Poza[1,2], Patty P.M.F.A. Mulder[1], Elisabeth Verpoorte[1]

[1]Pharmaceutical Analysis Group, Groningen Research Institute of Pharmacy (GRIP), University of Groningen, The Netherlands

[2]Present address: School of Science, Engineering and Design, Teesside University, United Kingdom

In this contribution, we exploit the use of Flow-Induced Electrokinetic Trapping (FIET) to achieve highly efficient separations of particle samples in microfluidic channels. FIET is a particle-trapping mechanism developed in our lab that relies on bidirectional, recirculating flow profiles generated by opposition of pressure-driven (PF) and electroosmotic (EOF) flows in straight channels that expand at both ends [1]. Micrometer-sized particles are captured in the recirculating streamlines and fractionated according to differences in surface charge (zeta potential, ζ) [2] and size [3].

We have characterized the FIET-based separation of binary samples in terms of the actual retention that particles experience along the FIET channel [4]. In this context, retention manifests itself as the positioning of the beads along the channel distance according to the acquired velocities in the bidirectional flow. Experimentally, this parameter can be precisely controlled using regular, stepwise voltage programs while keeping constant the PF velocity. Particle retention is thus evaluated at each voltage step by the difference in bead populations within two identical 450-µm-wide windows defined at either end of the channel (Δn_p). High values of Δn_p mean strong trapping, whereas low values indicate overall weaker retention as indicated by the observation of fewer trapped particles in the channel.

The orthogonal fractionation of three particle types has been performed for the first time at varying but controlled ΔV and ΔP. The first dimension pursued the size-based separation of carboxylated polystyrene (PS-COOH) beads, followed by a second dimension that consisted of the charge-based separation of PS-COOH beads and fluorescent polystyrene beads. The three particle fractions were finally collected with no observed impurities stemming from the other particle types. This dual-mechanism technique will be further developed and oriented towards cell and other bio-particle separations.

REFERENCES

[1] Lettieri, G.-L., Dodge, A., Boer, G., de Rooij, N.F. and Verpoorte, E., *Lab Chip*, **2003**, *3*, 34–39.

[2] Jellema, L. C., Meyer, T., Koster, S. and Verpoorte, E., *Lab Chip*, **2009**, *9*, 1914–1925.

[3] Jellema, L. C., Markesteijn, A.P., Westerweel, J., and Verpoorte, E., *Anal. Chem.* **2010**, *82*, 4027–4035.

[4] Fernandez-Poza, S., Mulder, P.P.M.F.A., Verpoorte, E., MicroTAS 2016: 20th International Conference on Miniaturized Systems for Chemistry and Life Sciences (Dublin), *Proceedings*, 1547-1548 (**2016**).