Stir Bar Sorptive Extraction (SBSE)

Established, Useful and Quite Often Simply the Extraction Technique of Choice

Stir Bar Sorptive Extraction (SBSE), based on the patented GERSTEL Twister, is a fully established technique in the world of chromatography. Quite often, SBSE is simply the method of choice. Professor Pat Sandra, SBSE inventor and founder of the Research Institute for Chromatography in Kortrijk, Belgium, casts some light on the beginnings of SBSE, the current status and what the future may hold.

By Professor Pat Sandra,
founder of the Research Institute for Chromatography (RIC), Kortrijk, Belgium

Professor Pat Sandra The Inventor of SBSE, Professor Emeritus Pat J. Sandra received his Master's degree in Organic Chemistry in 1969 followed by a Ph.D. degree in Analytical Chemistry in 1975 from the Ghent University, Belgium. He joined the Faculty of Sciences of the Ghent University in 1976 as Assistant Professor and was promoted to Full Professor of Separation Sciences in 1988. In 1986 he founded the Research Institute for Chromatography in Belgium, a center of excellence for research and education in chromatography, mass spectrometry and capillary electrophoresis. He was Co-founder of the Pfizer Analytical Research Center (PARC) that he directed during the period 2003-2011. During this time he has authored or co-authored over 500 scientific publications. Among numerous awards are the ACS Chromatography Award (2005) and Doctor Honoris Causa degrees in Pharmaceutical Sciences, in Food Safety and in Chemical Engineering. In 2013, he was appointed member of the Research Council of President Barroso of the EU commission.

Stir bar sorptive extraction (SBSE) was developed as a reaction to a negative comment on one of our publications related to the partitioning mechanism occurring between polydimethylsiloxane (PDMS) and water [1]. Theoretically, absorption (sorption) and not adsorption is taking place but this was obscured by adsorption of polychlorinated biphenyls (PCBs) on a PTFE stir bar. Coating the stir bar with PDMS resulted in 100 % absorption of the PCBs proving the partitioning mechanism and the relation with the octanol/water distribution coefficient. SBSE was introduced in 1999 as a solvent-less sample preparation technique combined with thermal desorption coupled online to capillary GC. It immediately became clear that this new method offered unprecedented sensitivity for compounds with a log P value larger than 3. For compounds with log P < 3, several in-situ derivatization methods were developed to cope with more polar compounds in different matrices e.g. food, beverages, biological fluids, etc. SBSE combined with liquid desorption was the next step in its development opening the combination of SBSE with liquid chromatography and the electrically-driven separation methods. Initially SBSE was mostly used for the extraction of compounds from aqueous matrices. The technique has also been applied in headspace mode for liquid and solid samples and in passive air sampling mode. Initially it was not our intention to commercialize SBSE – our hope was simply to have a good scientific outcome of this work. With approximately 1000 citations in the literature that hope has certainly been realized. However, GERSTEL showed strong interest in the technique and commercialized SBSE under the name "Twister®". Thanks to this move, the great potential of the technique has been shown over and over again.

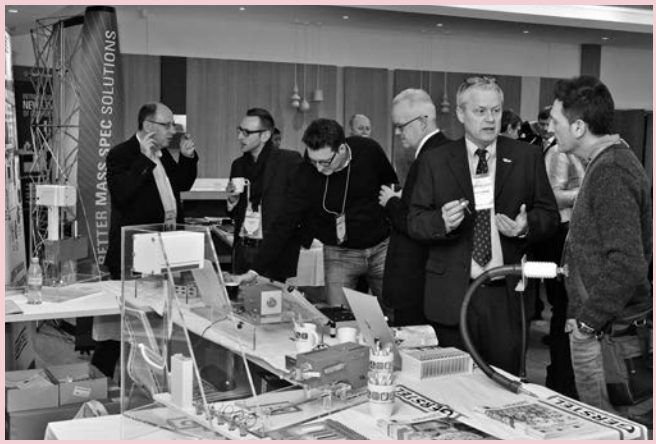
The benefits of the Twister technology

The main features and advantages of the SBSE technique are that it is a green sample preparation technique; analyte recovery is predictable and can be calculated from the log P value; very low detection limits (ppq's have been mentioned e.g. for organotin compounds) can be reached as well as excellent reproducibility; different *in-situ* derivatization methods are available, broadening the technique to compounds with low log P values and at the same time, improving chromatographic performance; a wide variety of matrices can be handled; and further clean-up steps are not needed (as opposed to other recently introduced sample preparation techniques). Moreover, the method is cost efficient since the Twisters can be reused many times. More recently, GERSTEL has developed an additional coating: Ethylene glycol – silicone (EG-Silicone) Twisters have become available, leading to high recovery extraction of specific solutes in a wide variety of matrices (beverages, biological flu-

ids, etc.). Any new analytical method needs high visibility to become successful. GERSTEL considered the Twister an important development and marketed the product accordingly. Soon after its commercialization, David Benanou from Veolia Water in Paris demonstrated the enormous potential of the Twister for detection of off-odors in drinking water and became one of the first proponents of the technique. Moreover, through his organization, he introduced the technique in several laboratories worldwide. He organized the first SBSE symposium in Paris in 2011 and decided to make this a biennial event. This year we had the third SBSE Technical Meeting with a strong international presence including speakers from laboratories in France, Belgium, the US, Japan, the Slovak Republic, the Czech Republic and Italy. This symposium series has definitely contributid to the spread of the Twister technology. In the past, one of the comments often heard about the Twister was: "It is too sensitive; we do not like to see all those compounds at ultra-trace levels." However, in recent years environmental concerns have increased tremendously, reducing the maximum allowable levels of several contaminants to extremely low values (ppq's for organotin compounds in water samples, zero tolerance of pesticides in baby food, etc.). The application of techniques like SBSE with its extreme power of concentration, will become mandatory to ensure the required accuracy and precision at these levels. Also, new analytical challenges are emerging for which Twister technology can be extremely useful. To mention a few examples: domestic passive sampling to elucidate endocrine disrupting chemicals, detection of allergens in cosmetic products, detection of toxic substances in shipping containers, release of chemical products from packaging materials, etc. Also, new Twister coatings can be developed for untargeted or targeted analysis. A polymer based on ionic liquids can be the next candidate for coating that small stir bar. The Twister technology is definitely on the move!

Literature

[1] E. Baltussen *et al.*, Study into the Equilibrium Mechanism between Water and Poly(dimethylsiloxane) for Very Apolar Solutes: Adsorption or Sorption? Analytical Chemistry 10 (1999) 71(22). DOI: 10.1021/ac990313g



Impressions from the SBSE technical meeting: Stimulating discussions about applications, trends, and possibilities of SBSE.

▲ SBSE Technical Meeting organizer David Benanou poses a question.

SBSE methodology was actively discussed in smaller groups during session breaks.

It is always worth listening to experienced users. GERSTEL Marketing Manager Kaj Petersen in conversation with Naïke Noyon, Research Engineer from CIRSEE, SUEZ environnement's main Research and Expertise Centre near Paris. Mr. Noyon presented his work on interaction of disinfectants with polymer pipes at the SBSE conference.