Green analytical methods

Miguel de la Guardia • Sergio Armenta

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In 1995 an analytical journal published the first small issue on green analytical chemistry entitled “Environmentally conscientious analytical chemistry”, which was devoted to environmental deleterious side effects of analytical methods, thus indicating that, in spite of the great advances in automation, miniaturization, and alternative sample treatments (such as the use of microwave-assisted processes instead of convective ones), the environmental conscience of the analytical community was less interested in these advances than in the need to reduce the costs of determinations and to increase laboratory productivity. After that, the success of the green chemistry revolution led by Paul Anastas provided a good frame in which both the ethical concerns regarding the planet’s future and business opportunities could be conveniently integrated.

The excellent reviews of Jacek Namiesnik and the first book on the subject of green analytical chemistry, published by Mihkel Koel and Mihkel Kaljurand in 2010, together with our own book and two additional ones edited with Salvador Garrigues, have created an important critical mass on the topic. Additional special issues in analytical journals devoted to this subject have been published since 2008 and have contained a number of important contributions, and so we can conclude that editors and authors are finally very concerned about the elimination of or, at least, reduction of the risks of analytical operations for both operators and the environment.

However, there is still a lack of green analytical methods as alternatives to classical ones, and most of the interesting and highly cited publications in the field are review papers.

The late 1970s provided many of the practical tools to move procedures from in-batch to mechanized and automatized methods, to reduce the amounts of reagents and samples consumed, to reduce drastically the power required, and to move from high-voltage equipment to low-voltage portable equipment. The last five years has provided a substantial revision of the opportunities offered by greening the methods. So, now it is time to move from the bench to the real world.

Because of the aforementioned reasons, this special issue of *Analytical and Bioanalytical Chemistry* is an attempt to explore real alternatives: without sample handling or with highly reduced sample handling, alternative solvents and reagents that do not have persistent biocumulative and toxic effects, great reduction of the contact between samples and reagents and operators, and the online detoxification of wastes.

In this sense, it is a new ambition to move from theory to practice, and upon analyzing the strengths and weakness of the methods proposed here and the opportunities they provide, the reader can identify that these methods will move analytical chemistry into the future and be well integrated in the ecological paradigm of chemistry.

It is our aim that when reading the excellent contributions in this special issue of *Analytical and Bioanalytical Chemistry*, the reader can dream about the exciting suggestions that the proposed methods incorporate to solve real analytical problems, but also to create new green methods using similar tools for greening the reader's own work.

Nowadays, it is clear that journal editors and writers of scientific editorials trust in green analytical chemistry. The next step is that teachers could incorporate the green principles, priorities, and strategies of green analytical chemistry in their university activities and also that authors, method users, and policy makers could integrate these practices in their everyday work. A change in public opinion about chemistry in general and analytical chemistry in particular, together with the health of our planet, will be the reward for all these efforts.

M. de la Guardia (✉)
Department of Analytical Chemistry, University of Valencia,
46100 Valencia, Spain
e-mail: miguel.delaguardia@uv.es

S. Armenta
Departament de Química Analítica, Universitat Autònoma
de Barcelona Edifici CN Ciències nord,
08193 Cerdanyola del Vallès, Spain

Miguel de la Guardia obtained his position in analytical chemistry at Valencia University in 1991. He has published around 500 papers in analytical chemistry regarding sample preparation and automation, molecular and atomic spectroscopy, and chromatography. He has supervised 33 PhD students from Spain, Morocco, Iraq, Algeria, Brazil, and Egypt and has given invited lectures at conferences at numerous Spanish universities and also in France, Germany, Italy, Brazil, Venezuela,

Morocco, Turkey, China, Norway, the UK, the USA, Colombia, Egypt, Uruguay, Argentina, Switzerland, Estonia, the Netherlands, and Belgium.

Sergio Armenta obtained his PhD degree in analytical chemistry at the Universitat de València in 2006. He is currently a senior researcher of analytical chemistry in the Applied Chemometrics Research Group at the Universitat Autònoma de Barcelona. His research topics included coupling of automated flow systems with IR and Raman spectroscopic detection and vibrational spectroscopy combined with chemometrics. His current research fields include the devel-

opment of fast and sensitive analytical methods based on ion mobility spectrometry.