Application of a New Non-Radioactive Field Emission based Electron Source in Electron Capture Detectors

Cornelius Wendt[*1], Erik Bunert[1], Michael Bachmann[2], Felix Düsberg[2], Simon Edler[2], Christoph Langer[2], Robert Ławrowski[3], Matthias Hausladen[3], Rupert Schreiner[3], Stefan Zimmermann[1]

[1] *Leibniz University Hannover, Institute of Electrical Engineering and Measurement Technology, Appelstr. 9A, 30167 Hannover, Germany*

[2] *KETEK GmbH, 81737 Munich, Germany*

[3] *OTH Regensburg, Faculty of General Sciences and Microsystems Technology, 93053 Regensburg, Germany*

**phone: +49 511 762 14650, *e-mail: wendt@geml.uni-hannover.de*

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Since the introduction of the Electron Capture Detector (ECD) by Lovelock and Lipsky more than 60 years ago, ECDs have become one of the most sensitive and thus most important detectors in gas chromatography for the detection of electron affine substances like halogens and chlorofluorocarbons [1-4]. Although sensitivity and linearity of ECDs have been improved over time the principal of operation is still the same [2-4]. Free electrons generated by a radioactive electron source, such as ^{63}Ni, are captured by electron affine analyte molecules reducing the number of electrons, which otherwise reach the detector electrode inside the ECD. This current reduction is the primary detector signal, which is related to the concentration of analytes in the sample [1-4]. The radioactive electron source is easy to employ and does not need any external power supply or maintenance. However, due to legal restrictions and disposal costs there is a strong demand to replace radioactive electron sources in ECDs. Therefore, the research and development of non-radioactive electron sources is an ongoing task for many years. One approach is to emit electrons from a hot filament in a vacuum chamber and to accelerate these electrons for transmission through a thin gas-tight membrane to ambient pressure [3,5-8]. Recently, we introduced a non-radioactive ECD [3] that is now using an improved non-radioactive electron source based on field electron emission [9]. For high and constant electron transmission, a conductive membrane is used to avoid any charging effects [7].

The just 150 nm thin and 7 mm wide graphene membrane with a silicon support structure enables electron transmission at acceleration voltage of just 2.2 kV. Coupled to the ECD reaction chamber of [3], see Fig. 1, limits of detection in the low ppt_v-range and a high linearity similar to radioactive ECDs are now reached.

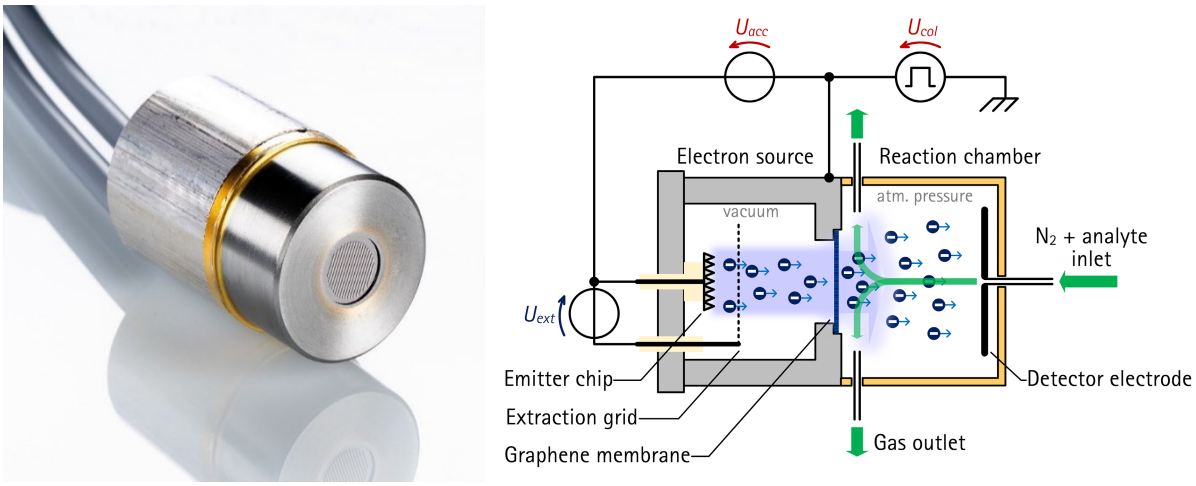

Fig. 1: Non-radioactive electron emitter based on field emission (left) [KETEK GmbH], schematic of a pulsed non-radioactive ECD (right)

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