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Online ¹⁴C analysis of ultra-small samples with accelerator mass spectrometry (AMS)

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14C measurements of samples containing 5-50 µg carbon allow dating of archeological artifacts or environmental materials with only traces of organic carbon. Furthermore, fossil and non-fossil sources of carbonaceous aerosols can be apportioned using such measurements (Szidat, 2009). The widely-used preparation of solid targets for 14C measurements, however, often remains the weak point of 14C analysis of ultra-small samples. Even under optimized conditions, reaction yields are small, which results in large isotopic fractionations or even in total loss of unique samples (Szidat et al., 2004). These problems are solved with the implication of a gas ion source (Ruff et al., 2007) at the next generation of small AMS machines: the mini radiocarbon dating system MICADAS is a prototype AMS that achieves the terminal voltage of 195 kV for 14C measurements with a vacuum-insulated high voltage platform in contrast to previous systems based on conventional particle accelerators (Synal et al., 2007). The self-constructed ion source of MICADAS was modified in order to insert CO2 gases directly to the focal point of the sputtering caesium beam (Ruff et al., 2007). A first gas handling system was constructed to supply the gas ion source constantly with CO2 from the sealed ampoules.

In this work, the concept of gas ion sources with its gas handling system will be presented. Furthermore, such ion sources allow on-line coupled systems of separation or combustion of organic compounds with AMS, which also will be elucidated. One example is the coupling of an elemental analyzer (EA), which generates a multifunctional system because it provides automated on-line combustion and 14C measurement of any organic material. Therefore, it can broadly be employed in 14C analysis. Carbon dioxide produced in the elemental analyzer is isolated from other combustion gases with a small external zeolite trap (Ruff et al., 2008). The purified CO2 is transferred from the external trap to the syringe with a low helium flow. This coupling principle can now be adapted to other combustion systems. Different approaches will be discussed.

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