sercon
innovators in isotopes

Application note 022

Stable isotopes in tree rings via Laser Ablation - Combustion - GC-IRMS

Studying stable isotopes in tree rings allows the reconstruction of past climate with annual resolution and statistically defined confidence limits[1]. A system has been developed by Sercon and Swansea University which allows the measurement of $\delta^{13}C$ values in tree rings via laser ablation - combustion - GC – IRMS. When this information is combined with EA-IRMS measurements of $\delta^{13}C$ values in leaves, this allows an evaluation of post-photosynthetic fractionation processes occurring at leaf level and downstream at high resolution during a growing season, and so the intra-annual pattern of $\delta^{13}C$ variability can be studied. Furthermore, when combined with $\delta^{18}O$ and δD measurements made via pyrolysis-IRMS, a multi elemental and isotopic study can be assimilated to reconstruct past climate, the reader is referred to applications note 023 for more details on the other instrumentation which can be used.

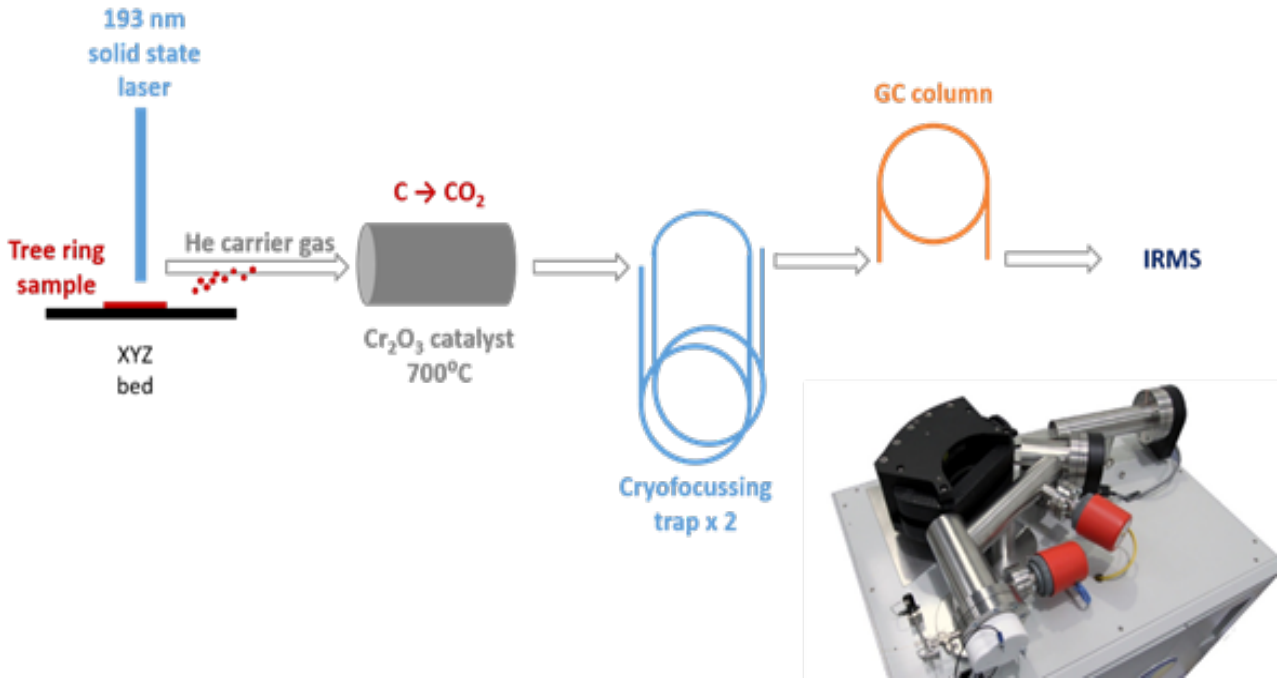
This applications note describes the system Sercon have developed at Swansea University, and goes on to describe the modifications made in collaboration with Teledyne Cetac. As the two leading manufacturers actively involved in development of the laser ablation - IRMS system, we are hosting workshops on the technique and invite researchers to collaborate with us, send us their samples, and explore whether this novel technique can be used to expand the research capabilities of their laboratories.

Sample preparation

Resin and other soluble materials were removed by placing the cores in a Soxhlet apparatus with ethanol for 3 days. The cores were then boiled in water, which was replaced every hour for 6 hours to remove the solvents completely. The cores were then dried in an oven at 40^0C for 2 days, then treated with a microtome to obtain a smooth, even surface for LA-IRMS analysis.

Sample analysis

The system consists of a 193 solid state laser (New Wave) which ablates the wood samples with a 40-µm diameter spot size (resolution), along continuous tangential lines spaced along the same radial line every 40 µm. The laser ablation process creates a stream of wood particles in a flow of helium, which is kept to a minimum to reduce fractionation effects. These particles are carried through to a Cryoprep (Sercon) where they pass through a combustion oven where the C in the sample is converted to CO_2 in the presence of oxygen and a Cr_2O_3 catalyst at 700°C. The CO_2 is then cryogenically trapped in 2 subsequent stainless steel traps immersed in liquid nitrogen – the first trap collects the CO_2, the second focuses and sharpens the peak for improved sensitivity. The CO_2 is then purified via a temperature controlled GC column, before entering the Sercon IRMS for isotopic analysis.



Further developments

The Sercon - Teledyne Cetac system which has been optimised for laser ablation IRMS consists of a solid state 213 laser connected to an ARIS system. The 213 laser produces small particles of a narrow particle size distribution, has low heating effects and therefore very low fractionation effects during laser ablation. The ARIS system ensures effective transport of the sample at low flow rates, ensuring small sample sizes give a high enough signal on the IRMS. The Sercon HS20-22 has a high sensitivity source which further increases instrument sensitivity and measurement precision.

[1] McCarroll and Loader, Quaternary Science Reviews 23, Issues 7-8, 771-801, 2004

Swansea University
Prifysgol Abertawe

TELEDYNE
CETAC TECHNOLOGIES
Everywhereyoulook™

info@sercongroup.com
www.sercongroup.com