

Macro Elemental Analysis and Isotope Ratio Mass Spectrometry

vario MAX IRMS



The determination of the isotope ratios ^{15}N , ^{13}C or ^{34}S (IRMS) in addition to the precise total concentration of C, N and S by elemental analysis (EA) has become an important method for general soil and plant research as well as for investigation of origin, quality and forgery of food such as meat, dairy products and wine. Up to now, such kinds of analysis were done on the micro scale with high requirements on laboratory and operation conditions as well as costs. But the routine analysis of natural samples will require the following:

- large weighing range from milligram to gram
- easiest sample handling and instrument operation
- large concentration range for element determination
- low cost for investment, installation and operation

vario MAX IRMS the world's first EA-IRMS system for macro samples fulfills all these requirements. ELEMENTAR opens a new dimension in IRMS analysis with the **vario MAX** in addition to its micro and semi-micro analyzer **vario EL IRMS**.



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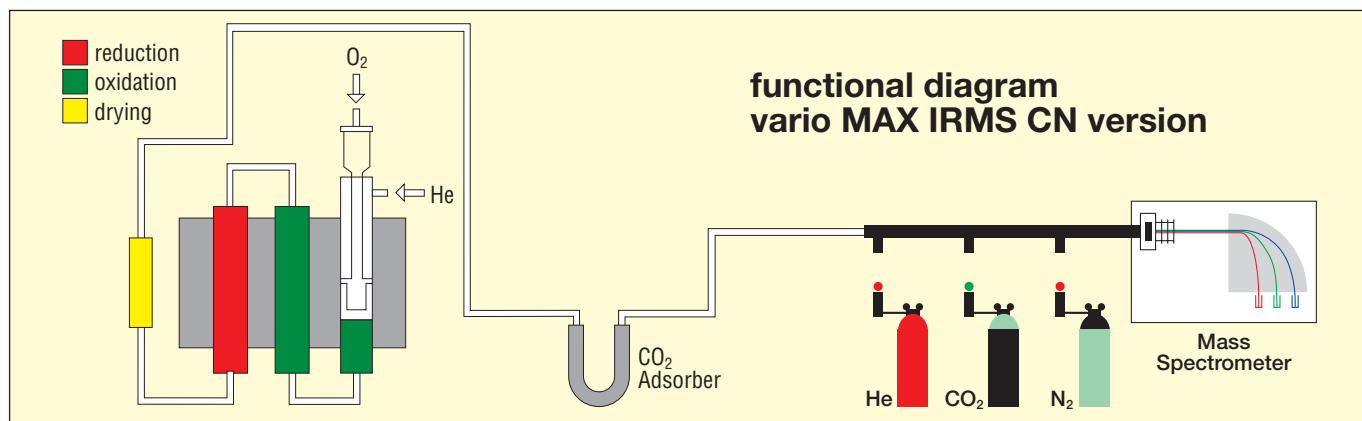
ELEMENTAR has more than 100 years of experience in developing elemental analyzers and is the pioneer of macro sample analysis.



100 mg up to 1000 mg of soil, 200 mg plant material, 1 ml milk or wine are weighed into open and reusable stainless steel or ceramic crucibles and placed on a 60-position sampler. The rest is fully automatic including the recording of the element concentrations of CN or CNS (depending on instrument version) in addition to their isotope ratios. The instrument also operates unattended and over night.



An integrated robotic arm picks up the crucible and lowers it into the combustion tube. At approx. 900°C respectively 1150°C a complete combustion digestion takes place in an oxygen atmosphere. The combustion gases are processed and separated into their components (e.g. CO₂, N₂, SO₂), after NO_x is reduced to N₂ on hot copper which also absorbs the excess oxygen. Detection of the components in the helium carrier gas for concentration determination of C, N or S takes place on a thermoconductivity cell (TCD). Subsequently the gases are lead into a powerful sectorfield mass spectrometer (AP 2003) where the isotope ratios of ¹⁵N/¹⁴N, ¹³C/¹²C and/or ³⁴S/³²S are measured in comparison with calibration gases. Instrument control and data processing of the entire system **vario MAX IRMS** is done from a central PC under Windows®. After the measurement the sample crucible is automatically removed from the combustion zone and can be used again.



Successful application made easy

In contrast to existing EA-IRMS systems **vario MAX IRMS** requires only approx. 1.20 m laboratory bench, a simple 0.1 mg analytical balance and the gases He and O₂ as well as CO₂ and N₂ (optional SO₂) for calibration.

Historically successful operation of EA-IRMS systems has been limited to specialized mass spectrometry laboratories. However, due to the ease of sample handling, operation and maintenance, the **vario MAX IRMS** may be successfully operated in a wide variety of laboratory settings. Labs specializing in plant material, soil, food quality, customs inspection or forensic, to name a few, could benefit from having a **vario MAX IRMS** system.

Soil and plant material samples benefit from high sample weight and automatic ash removal after combustion.

sample	weight	N %	C %	$\delta^{15}\text{N} \text{ ‰}$	$\delta^{13}\text{C} \text{ ‰}$
wheat	approx. 150 mg	3.81	42.37	1.94 ± 0.01	-27.72 ± 0.07
winter wheat	approx. 210 mg	2.55	41.28	4.86 ± 0.06	-23.46 ± 0.07
forest soil	approx. 375 mg	1.52	34.50	-5.86 ± 0.22	-26.30 ± 0.04
sandy soil	approx. 550 mg	0.41	6.30	7.67 ± 0.03	-26.43 ± 0.06

Food and semi-luxuries disclose their origin.

butter	weight	N %	C %	$\delta^{15}\text{N} \text{ ‰}$	$\delta^{13}\text{C} \text{ ‰}$
Ireland	approx. 60 mg	0.10	64.3		-32.49 ± 0.06
Normandy	approx. 60 mg	0.10	65.8		-17.97 ± 0.01
Bavaria	approx. 60 mg	0.10	62.8		-24.58 ± 0.01
beef					
Germany	approx. 90 mg	3.8	20.2	6.50 ± 0.12	-21.72 ± 0.02
Brasil	approx. 90 mg	3.3	12.8	7.20 ± 0.09	-10.24 ± 0.05
red wine (Tempranillo)					
Rioja Ugarte 1999	approx. 300 mg	0.05	5.47		-25.95 ± 0.04
Rioja Grignon 1999	approx. 300 mg	0.05	5.68		-25.62 ± 0.05
Navarra Sardosol 1997	approx. 300 mg	0.05	5.76		-26.81 ± 0.05
tobacco (cigars)					
Domin. Republic	approx. 90 mg	4.11	36.2	8.53 ± 0.01	-27.01 ± 0.09
Louisiana	approx. 90 mg	3.58	36.5	6.01 ± 0.02	-28.07 ± 0.02
honey					
Germany (rape)	approx. 100 mg	0.03	32.5		-27.04 ± 0.02
Provence (blossoms)	approx. 100 mg	0.04	32.7		-26.26 ± 0.05

Sulfur determination also in macro scale (CNS version).

sample	weight	S %	$\delta^{34}\text{S} \text{ ‰}$
sulfur (soufre de lacq NIST, $\delta^{34}\text{S} + 16.65$)	approx. 0.5 mg	100.00	16.53 ± 0.27
sulfadiazine	approx. 3.5 mg	12.85	11.80 ± 0.19
lentils (France)	approx. 150 mg	0.26	7.26 ± 0.02
lentils (Argentina)	approx. 100 mg	0.29	-1.47 ± 0.08

Specification vario MAX IRMS

Operating modes / instrument versions:	CN, CNS	
External precision of isotope analysis:	$^{13}\text{C} \leq 0.2 \text{ ‰}$, $^{15}\text{N} \leq 0.2 \text{ ‰}$, $^{34}\text{S} \leq 0.4 \text{ ‰}$ (for CN: 50 mg glutamic acid resp. 120 mg wheat, for S: 0.7 mg sulfadiazine)	
Precision of elemental analysis:	$\leq 0.5 \text{ ‰}$ relative (approx. 100 mg test substance)	
Measuring range of elemental analysis:	CN version	CNS version
	N: 0.02 - 150 mg	0.02 - 30 mg
	C: 0.02 - 400 mg	0.02 - 200 mg
	S: -	0.02 - 15 mg
Sample weight:	1 mg up to approx. 1000 mg (depending on substance) up to approx. 300 mg for plant samples up to approx. 1000 mg for soil samples	
Autosampler:	60 positions as standard with reusable steel or ceramic crucibles (approx. 5 ml volume)	
Digestion temperature:	950°C - 1150°C	
Analysis time:	self-adjusting, depending on element content and weight e.g. CN simultaneously: approx. 16 min for CN / 20 min for CNS	
Gas consumption per analysis:	He: approx. 20 l O ₂ : approx. 100 - 300 ml N ₂ (calibration): approx. 2 m ³ /month CO ₂ (calibration): approx. 2 m ³ /month SO ₂ (calibration): approx. 1 m ³ /month	
Gas purity:	He: 99.995 % purity (with cleaning cartridge) O ₂ : 99.995 % purity	N ₂ : 99.995 (calibration) CO ₂ : 99.995 (calibration) SO ₂ : 99.9 (calibration)
Dimensions: (WxDxH cm)	vario MAX IRMS 78 x 60 x 110 cm	AP 2003 35 x 63 x 65 cm
Weight:	approx. 130 kg	approx. 77 kg mass spectrometer approx. 20 kg pump
Capacity:	1,6 KW	2 KW
Power supply:	230 VAC, 50/60 Hz	230 VAC, 50/60 Hz

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