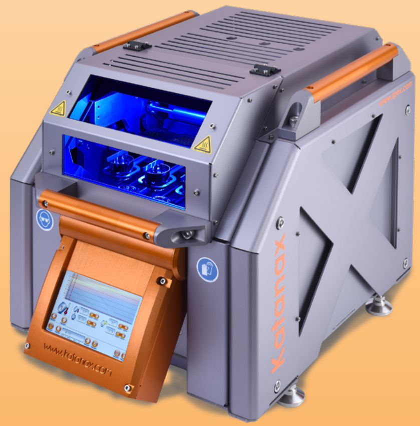
BORATE FUSION FOR NUCLEAR DECOMMISSIONING

Katanax X-300
X-FLUXER®



KATANAX FUSION FLUXER

Today, more labs are using electrical heating for Borate Fusion. The X-300 is a one, two or three position, fully automated, electric fusion machine with a sample throughput up to 15 samples per hour. It is ideal for preparing fused beads for XRF analysis and solutions for AA, ICP, wet chemistry analysis and radio analytical sample preparation.

Automated control of fusion parameters including heating time, temperature, mixing time, rate and cooling time for glass disks or stirring time for solutions.

Borate fusion is well-established as a means of fusing oxide materials (encompassing many minerals and rocks). Borate fusions are effective in dissolving most silicates, oxides, phosphates and sulphates. It can also be applied to organic-rich and sulphidic materials and even metals if preceded by an oxidation step. The technique allows a wide range of sample matrices (e.g. cement, ores and minerals, sludges, slags and soils) to be prepared for downstream trace elemental analysis in an analytical testing lab.

The rapid expansion of geochemistry from the 1960s onward was linked to advances in wavelength dispersive X-ray fluorescence spectrometry (WDXRF). In the 1970s researchers pioneered the application of borate fusion to rapidly dissolve geological samples to produce homogeneous fused beads or glass disks by casting the melt into a platinum alloy dish. The WDXRF method was ideally suited to measure 50 or more elements on the glass disks produced. With the advent of ICP-OES and ICP-MS, analysts also used lithium borates to fuse samples and pour the melt into water to rapidly quench and fragment the quenched glass. This fragmentation enhanced the speed of subsequent acid dissolution of the borate glass and allowed the solutions to be measured on the ICP instruments.

In its early days, the borate fusion of materials was largely achieved using manual handling and gas burners or electric muffle furnaces. Current systems still employ gas or electrical heating but are considerably more sophisticated and enable a good degree of automation. Electrical heating systems are considerably more attractive than gas-based systems for hazardous environments such as nuclear sites.

INNOVATIONS IN RADIOANALYTICAL CHEMISTRY

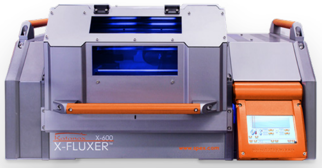
Given the beneficial characteristics of borate fusions (speed, ability to dissolve a broad range of materials and positive safety considerations) it is an ideal technique for radioanalytical chemistry. The application was pioneered by Professor Ian Croudace in the GAU Radioanalytical Laboratories of Southampton University (UK).

The first reported application of borate fusion in radioanalytical sample preparation related to a 1996 research contract that required the rapid isotopic analysis of U and Pu in 650 soil samples over no more than 3 months (see Refs). This high public profile study focused on investigating ground contamination from alleged damage to a nuclear weapon at the former USAF airbase at Greenham Common in the UK. Prior to this work, radioanalytical specialists would traditionally have used one or more sample digestion approaches to extract U and Pu (and other elements with radioactive species) from soils. The traditional methods were slow and in some cases hazardous (e.g. HF acid attacks or fusions with alkali fluorides, carbonates, peroxides).

Recognition of the speed potential and overall superiority of borate fusion came from a crossover insight by the project leader Ian Croudace who had more than 25 years experience in both radioanalytical procedures as well as in XRF analysis.

BORATE FUSION

FOR NUCLEAR DECOMMISSIONING



Katanax X-600

X-FLUXER®

Six-position heavy-duty fully automated electric fusion fluxer with a throughput of up to 30 samples per hour. Prepares glass disks (beads) for XRF, solutions for ICP/AA and peroxide or pyrosulfate fusions.

OTHER USEFUL PRODUCTS FOR SAMPLE PREPARATION

MIXER/MILL®

High-energy ball mill that accommodates sample sizes ranging from 0.2 - 10 grams. Ideal for grinding dry, brittle samples such as rocks, minerals, cements and soils.

8530 SHATTERBOX®

Ring & Puck mill with sound-proof enclosure that accommodates sample sizes ranging from 2-100 grams. Ideal for pulverizing dry, brittle samples and slurry grinding.

2010 GENO/GRINDER®

Used to extract toxic elements from plant and animal tissue samples. High-throughput homogenizer with an adjustable clamp that accommodates up to six deep-well titer plates and 16 centrifuge tubes.

Since its innovative development in 1996, GAU-Radioanalytical Laboratories, as a major provider of waste characterization services to the nuclear decommissioning sector, has continued to spearhead the application of borate fusion technology. The method is central to several of its accredited (ISO17025) procedures and serves to enable safe and effective extraction of many radionuclides from complex sample matrices.

The Katanax range of instruments, designed for efficient borate fusion, includes the X-300. This compact instrument is capable of being operated in fume cupboards which are likely to be required on nuclear on-site laboratories. The X-300 uses robust electric heating elements that give excellent temperature control. There are no flames and has an integreted safety shield. The instrument is simple to use and fully automated allowing the operator to walk away and collect samples once the cycle is complete.

Radioanalytical Applications

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- *Taylor, R.N., Croudace, I.W., Warwick, P.E. and Dee, S.J. (1998) Precise and rapid determination of 238U/235U and uranium concentration in soil samples using thermal ionisation mass spectrometry. Chemical Geology, 144, 73-80.*
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- *Croudace I.W., Warwick P.E., Warneke T., Cundy A.B. and Taylor R.N (2001) Assessment of radioactive contamination around the AWE sites in Berkshire. Report 3 (FINAL) to AWE plc,90pp.*
- *Reading DG, Croudace IW, Warwick PE, Britton R. (2015) A rapid dissolution procedure to aid initial nuclear forensics investigations of chemically refractory compounds and particles prior to gamma spectrometry. Anal. Chim. Acta, (in press)*

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Geosciences Advisory Unit (GAU) Application Areas:

- Nuclear Decommissioning
- Nuclear Waste Characterization
- Reference Sample Characterization
- Nuclear Forensics