



TA INSTRUMENTS

Microcalorimetry



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MICROCALORIMETRY

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QUALITY PRODUCTS

All TAM Microcalorimeters are manufactured in our Järfälla, Sweden facility. Continuing on the superior standards of our predecessor company Thermometric, all TAM systems are precisely constructed by a motivated, highly skilled workforce. The result is a combination of unparalleled quality and reliability.

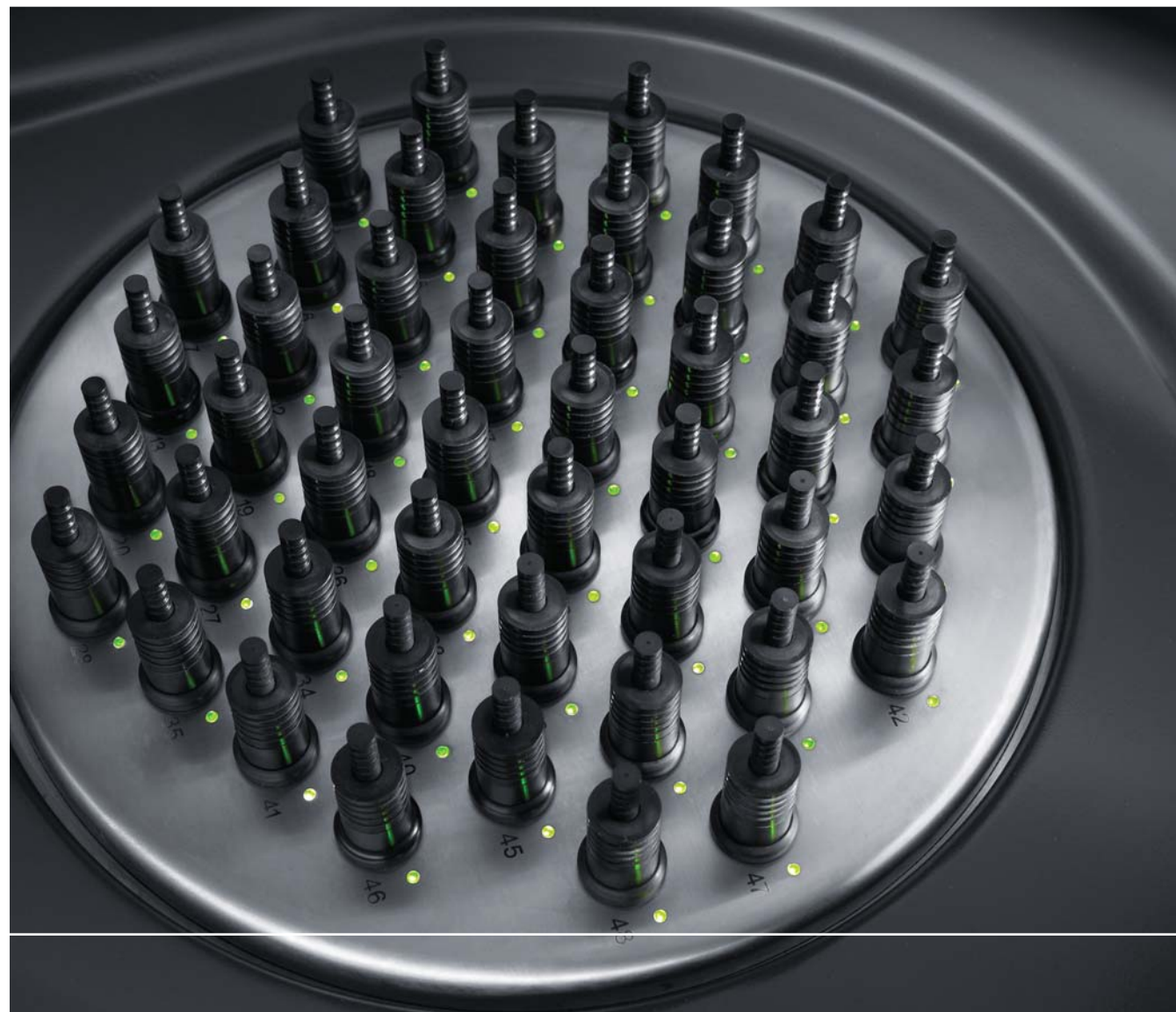


TAM

SENSITIVE · VERSATILE · RELIABLE

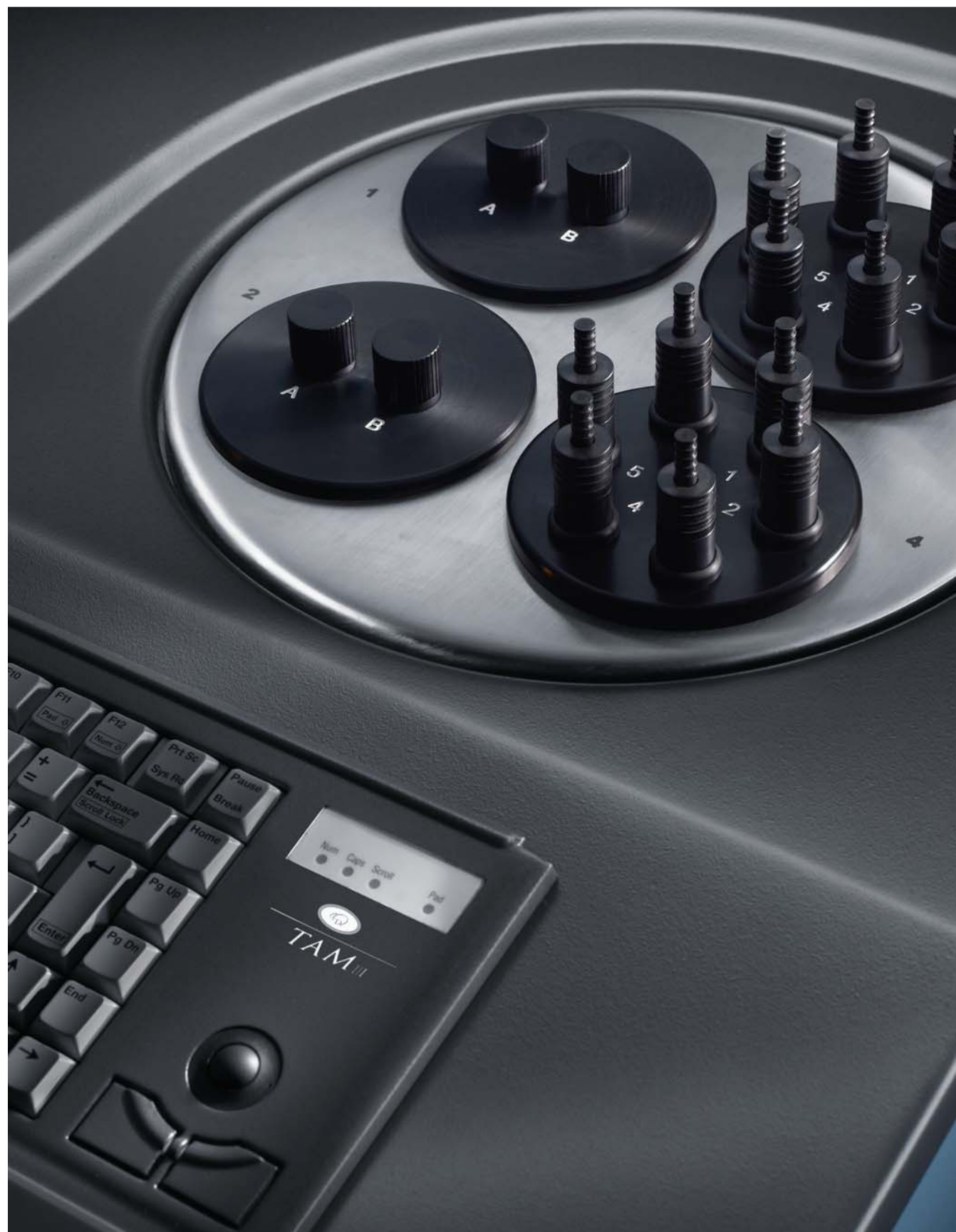
TAM MICROCALORIMETERS

TAM represents an ultra-sensitive heat flow measurement which is complementary to TA Instruments differential scanning calorimeters. Based on the pioneering Thermometric technology, TAM offers maximum sensitivity, flexibility, and productivity. It can be used with the most sensitive microcalorimeters and a wide variety of accessories to control the experimental conditions.



TA INNOVATIONS

2277 BAM - Bio Activity Monitor
2277 TAM Thermal Activity Monitor
Isothermal Titration Calorimetry
Flow / Mix Calorimetry
Perfusion Calorimetry
Precision Titration Calorimetry
Precision Solution Calorimetry
TAM 48 - 48 Simultaneous Samples
TAM III - Thermal Activity Monitor
Multicalorimeter
Nanocalorimeter



TAM III

TAM III is the new generation, multi-channel, microcalorimetric system from TA Instruments. TAM offers maximum sensitivity, flexibility, and performance. It can be used with the most sensitive microcalorimeters and a wide variety of accessories to precisely control the experimental conditions. Up to four independent calorimeters can be used simultaneously with TAM III, to perform repetitive or different types of experiments. TAM III is totally modular and enables multiple calorimeters to be added to increase sample capacity or functionality. With the addition of a multicalorimeter holding six independent minicalorimeters, the sample throughput is substantially increased. TAM III employs patented thermostat technology to precisely control the liquid bath temperature to within 0.0001°C, and can be operated in isothermal, step-isothermal or temperature-scanning mode.



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THERMOSTAT SPECIFICATIONS

Thermal Media	Oil (Water)
Calorimeter Positions	1 - 4
Temperature Range	15 - 150°C (90°C)
Accuracy	< ± 0.1 °C
Long Term Stability	< ± 100 µK/24h
Short Term Stability	< ± 10 µK (p-p)
Scanning Rate	< ± 2°C/h (between 20 - 150°C)
Step-wise Change of Temperature	
Heating	15°C/h at 15°C - 2°C/h at 150°C
Cooling	15°C/h at 150°C - 1.5°C/h at 15°C

CALORIMETER SPECIFICATIONS

CALORIMETER	SHORT TERM NOISE	BASELINE DRIFT	ACCURACY	PRECISION
Nanocalorimeter	< ± 10 nW	< 20 nW/24 h	< 1%	± 100 nW
Minicalorimeter / Multi	< ± 100 nW	< 200 nW/24 h	< 5%	± 200 nW
Microcalorimeter 20ml	< ± 100 nW	< 200 nW/24 h	< 1%	± 100 nW
		DETECTABILITY		
Solution Calorimeter	< ± 10 µK	1-4 mJ	< 0.1%	Q > 100 J: 0.02% Q < 50 J: ±10 mJ Q < 0.1 J: ±5 mJ

TAM 48

The TAM 48 is a special version of the TAM III thermostat with unique features designed to maximize sample throughput without sacrificing data quality. Up to 48 independent minicalorimeters can be operated simultaneously with the TAM 48, to perform different experiments in each of the 48 calorimeters or to perform repeat experiments simultaneously. The design accommodates minicalorimeters in batches of 12. The TAM 48 employs patented thermostat technology to precisely control the liquid bath temperature to within 0.0001°C, and can be operated in isothermal, step-isothermal or temperature-scanning mode.



THERMOSTAT SPECIFICATIONS

Thermal Media	Oil (Water)
Calorimeter Positions	1 - 48
Temperature Range	15 - 150°C (90°C)
Accuracy	< ± 0.1°C
Long Term Stability	< ± 100 µK/24h
Short Term Stability	< ± 10 µK (p-p)
Scanning Rate	< ± 2°C/h (between 20 - 150°C)
Step-wise Change of Temperature	
Heating	15°C/h at 15°C - 2°C/h at 150°C
Cooling	15°C/h at 150°C - 1.5°C/h at 15°C

CALORIMETER SPECIFICATIONS

CALORIMETER	SHORT TERM NOISE	BASELINE DRIFT	ACCURACY	PRECISION
Minicalorimeter / Multi	< ± 100 nW	< 200 nW/24 h	< 5%	± 200 nW

TAM AIR

The TAM Air is an eight channel microcalorimeter from TA Instruments designed for sensitive and stable heat flow measurements. It is the ideal tool for research and development of new formulations as well as quality control during cement and concrete manufacture and preparation. TAM Air is also ideal for other large-scale calorimetric experiments requiring sensitivity in the milliwatt range. The operating temperature range is 5-90°C. All calorimetric channels are of twin type, consisting of a sample and a reference vessel, each with a 20 ml volume. The thermostat employs circulating air and an advanced regulating system to keep the temperature very stable (within ± 0.02°C). The high accuracy and stability of the thermostat makes the calorimeter well suited for heat flow measurements over extended periods of time, e.g. weeks.



THERMOSTAT SPECIFICATIONS

Calorimeter Positions	8
Operating Temperature Range	5 - 90°C
Thermostat Type	Air
Thermostat Accuracy	± 0.02°C
Limit of Detection	4 µW
Precision	± 20 µW
Baseline over 24 hours	
Drift	< 40 µW
Deviation	< ± 10 µW
Error	< ± 23 µW
Short Term Noise	< ± 2.5 µW

CALORIMETER SPECIFICATIONS

CALORIMETER	SHORT TERM NOISE	BASELINE DRIFT	ACCURACY	PRECISION
TAM AIR 8 Channel Calorimeter	< ± 2.5 µW	< 400 µW/24 h	< 5%	± 20 µW

TAM TECHNOLOGY

All chemical, physical and biological processes result in either heat production or heat consumption. Microcalorimetry is a versatile technique for studying this thermal activity in terms of heat, heat flow and heat capacity. TAM III offers unmatched sensitivity, long-term stability and high measuring capacity. The modular design, coupled with a wide range of accessories and auxiliary equipment, offers unrivaled flexibility.

TAM

THERMAL ACTIVITY MONITOR

Microcalorimetry can be completely nondestructive and non-invasive to the sample. It seldom requires any prior sample treatment nor does it limit analysis to a physical state of the sample. Solids, liquids and gases can all be investigated. Microcalorimetry does not require that a sample has a particular characteristic to enable measurement like FTIR, UV-Vis, NMR etc. Microcalorimetry is a direct and continuous measurement of the process under study. Unlike other analytical techniques that give "snapshots" of data, microcalorimetry gives real-time data continuously as the process proceeds.



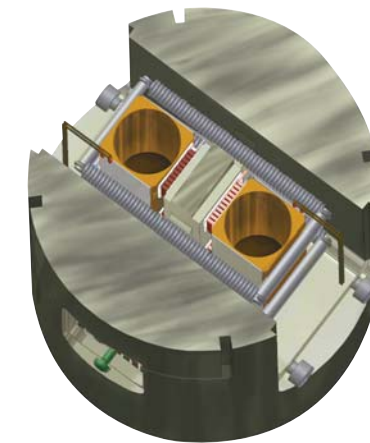
TAM OPERATING MODES

HEAT FLOW

All of the calorimeters available for TAM III are of the heat flow type except for the solution calorimeter, which is a semi-adiabatic calorimeter. A heat flow calorimeter works by channeling the heat produced or consumed by a reaction in the sample through heat flow sensors comprised of thermoelectric modules. When a temperature gradient is imposed across the thermoelectric module, a voltage is created in accordance with the Seebeck effect. This voltage is proportional to the heat flow through the thermoelectric module and hence proportional to the rate of heat production or consumption by the sample. One side of the thermoelectric module is in contact with the sample and the other is kept isothermal by a heat sink which is in contact with the TAM III thermostat. Because of the excellent stability of the TAM III thermostat, even over long periods of time, TAM III maintains outstanding sensitivity. All the heat flow calorimeters are of the twin type, consisting of both a sample and a reference side. The measured property is the difference in heat flow between sample and reference. The twin principle reduces baseline noise by eliminating any small fluctuations of the thermostat.

POWER COMPENSATION

TAM III can also operate in a power compensation mode. A constant electrical power is applied to the calibration heaters of the sample and reference sides of the calorimeter. If the temperature of the sample increases or decreases due to a reaction or physical event, the heater on the sample side is compensated to keep the sample and reference at the same temperature. The power compensation mode results in a much faster response time making the calorimeters ideal for high resolution while monitoring rapid processes. (Power compensation mode is not currently available with the minicalorimeter).



HIGH PERFORMANCE TEMPERATURE CONTROL AND STABILITY

The TAM III thermostat is a liquid based system, utilizing water or a mineral oil to quickly dissipate heat and minimize temperature gradients in the system. Efficient circulation of the liquid also permits precise temperature changes to be made. Temperature is controlled by a unique, patented regulation system. The average temperature fluctuation of TAM III is better than $\pm 10 \mu\text{K}$ over the range 15 to 150°C. The drift over 24 hours is within $\pm 100 \mu\text{K}$. The unmatched stability of the TAM III thermostat contributes to a perfect environment for isothermal and temperature scanning measurements (minicalorimeter). The thermostat is controlled by the software dedicated to TAM III - TAM Assistant™.

TEMPERATURE MODES

ISOTHERMAL

This is the classical mode for microcalorimetric experiments. The liquid thermostat is maintained at constant temperature for the duration of the experiment. Any heat generated or absorbed by the sample due to a chemical or physical process is continuously measured. Isothermal measurements give quantitative and continuous data reflecting the rate of the process under study.

STEP ISOTHERMAL

Step isothermal experiments can be performed on the same sample at different temperatures. During the isothermal phases, the same signal stability and sensitivity is achieved as with conventional isothermal experiments. During the temperature transition phases, heat flow is recorded to monitor how the sample is affected by the change in temperature. This mode is useful for the study of heat capacity and temperature dependence of chemical reactions.

SCANNING

TAM III can be used to perform experiments under extremely slow temperature scanning conditions. This enables the calorimetric response to be monitored over a linear temperature gradient. The slow scan rate (maximum 2 °C/h) allows large samples, up to about 4 ml, to be analyzed while they are in thermal, physical and chemical equilibrium. The excellent stability combined with large sample size makes TAM III far more sensitive than conventional DSC instruments. Furthermore, resolution is far greater for phase transitions. A scanning experiment can also be combined with an isothermal experiment, using as simple or as complicated a temperature profile as required.

TAM VERSATILITY

The TAM III is the most versatile microcalorimetric system available. The TAM III thermostat can be configured with a variety of independent calorimeters which allow multiple experiments and maximizes laboratory productivity.

- ISOTHERMAL TITRATION CALORIMETRY

- NANOCALORIMETER

- MICROCALORIMETER

- SOLUTION CALORIMETER

- PERFUSION CALORIMETRY

- 48-CHANNEL CALORIMETER



NANOCALORIMETER

HEAT DETECTOR SYSTEM OF THE NANOCALORIMETER

The Nanocalorimeter contains two heat detectors (thermoelectric modules) on the sample side and two on the reference side. The heat detectors are positioned on the inner side of the ampoule holder in between the ampoule holder and a surrounding heat sink (aluminum).

A foil heater is surrounding two alternate sides and the bottom of the ampoule holder and is used for calibrating and power compensation. A known electrical power can be produced and controlled by TAM III.

Active heat sink control is used in order to reduce the time constant of the calorimeter and reduce the time needed to reach thermal equilibrium after a change in temperature.

NANOCALORIMETER

The Nanocalorimeter is the most sensitive calorimeter for the TAM III, and is typically used in the isothermal mode. It combines high sensitivity with excellent baseline stability which makes it ideal for isothermal titration calorimetry (ITC) in studying molecular interactions. The nanocalorimeter holds all closed ampoules up to 4 ml. For highest sensitivity it is used with the 1 ml titration ampoule and a similar ampoule as reference. This reference ampoule contains an inert substance, (e.g. water or sand) in order to balance the heat capacity of the two sides. Thus, under normal conditions the heat flow associated with the reference ampoule will be negligible.



MICROCALORIMETER

MICROCALORIMETER - 20 ML

The 20 ml Microcalorimeter is a heat flow calorimeter of twin type. It has been designed to hold large samples, (e.g. batteries) and for experiments requiring a large gas phase above the sample. The microcalorimeter can be used with all 20 ml static ampoules and the 20 ml micro reaction system including titration facilities and control of the relative humidity during measurement.

The 20ml Microcalorimeter is also the only calorimeter that can be used with the micro solution ampoule. This ampoule is designed for dissolution of very small amounts of solids (a few mg) in different solvents and is ideal for dissolution of slowly soluble substances. The heat of dissolution and the kinetics of dissolution can be studied.



MINICALORIMETER

MULTICALORIMETER



MINICALORIMETER - 4 ML

The Minicalorimeter is a 4 ml Microcalorimeter with a special design to reduce the space occupied by the calorimeter inside the thermostat. The reference is positioned below the sample ampoule which allows up to 48 Minicalorimeters to be positioned in the thermostat. The Minicalorimeter is used in the Multicalorimeter and in the TAM 48 thermostat. It has been designed for increased sample throughput and is recommended for compatibility and stability testing.



MULTICALORIMETER

The TAM Multicalorimeter contains six Minicalorimeters. It is intended for use with the TAM III thermostat to increase the sample throughput. The TAM III thermostat can hold up to 24 individual calorimeters, as well as other types of calorimeters such as a Nanocalorimeter or a Precision Solution Calorimeter. These combinations offer the highest flexibility by combining high sensitivity with high sample throughput. It can be used for all applications designed for individual Minicalorimeters.

ISOTHERMAL TITRATION CALORIMETRY



TITRATION CALORIMETRY

Isothermal Titration Calorimetry requires the highest level of calorimetric sensitivity and stability, efficient titrant delivery, and a user-friendly platform which facilitates easy cleanup and rapid turnaround. Employing unique and proprietary technology, the TAM III is the ideal system for Isothermal Titration Calorimetry and excels in the most demanding ITC applications such as ligand binding.

The TAM Isothermal Titration Calorimetry (TAM-ITC) system consists of a nanocalorimeter, 1 ml removable titration ampoule with stirring facilities, and a precision syringe pump for efficient titrant delivery. The TA Instruments nanocalorimeter is the most sensitive calorimeter available for the TAM III, and can readily detect microjoule level heat flow. In power compensation mode, the response time of the calorimeter is optimized, and the temperature of the sample is held virtually isothermal. This is a major benefit over competitive designs, in which the sample temperature is allowed to drift during titration.



TITRATION AMPOULE

The removable ampoules offer a level of practicality unmatched in the industry. TAM-ITC ampoules are easily removed and cleaned outside of the instrument. Competitive designs feature fixed cells which require thorough cleaning between experiments, and preclude visual inspection. The open vessels of TAM-ITC ampoules also allows solid suspensions, solid matrixes with attached living cells, macromolecules, etc. to be loaded into the reaction vessel. This allows ligand binding to the solid system to be measured. There is no possibility for this kind of matrix experiment to be run on competitive fixed-cell instruments.

In TAM-ITC different sizes of syringes ranging from 100 μ L to 2.5 mL are available. The injections volumes/flow are controlled by a high precision syringe pump. Each pump can support two syringes. In addition, two pumps can be attached to one titration ampoule which is useful for studying enzyme kinetics. This option is not available in competitive designs.

PERFUSION CALORIMETRY

PERFUSION AMPOULE

The perfusion ampoule is the simplest micro reaction system available, and is typically used with the Nanocalorimeter. A liquid or gas is perfused through the ampoule and out through an exit tube. Gases are perfused using a mass flow controller that is controlled by TAM Assistant™ software. Liquids are perfused using a peristaltic pump. The perfusion ampoule can be used to measure either the heat production rate from a flowing gas/liquid or the effect of the gas/liquid on a sample placed in the perfusion ampoule. The perfusion ampoule is available in 1, 4 and 20 ml versions.

RH PERFUSION AMPOULE

The RH perfusion ampoule perfuses a gas of defined relative humidity over a sample and out through an exit tube. The relative humidity is controlled using two mass flow controllers, one of which passes gas directly to the sample and the other passes gas through two humidifying chambers prior to the sample. TAM Assistant™ software controls both the relative humidity and the total flow rate over the sample. The software is also used to change the humidity in a linear ramp or stepwise. The RH perfusion ampoule is available in 1, 4 and 20 ml versions. It is possible to use solvents other than water in the humidifying chambers which allows a gas of varying vapor pressure of a solvent to be passed over a sample.



PRECISION SOLUTION CALORIMETRY

PRECISION SOLUTION CALORIMETER

Solution Calorimetry refers to the determination of the heat of dissolution when a solid is dissolved in a liquid, or two liquids are mixed.

The TAM Precision Solution Calorimeter is a single-position, semi-adiabatic calorimeter for high precision measurements of the heat generated or consumed when a solid or liquid sample is dissolved or diluted into a solvent. The instrument is designed for highest accuracy and precision and is used in general thermodynamic investigations as well as for quantitative analytical measurements of various solid state phases. It is available with a 25 ml or 100 ml vessel, and is intended for use with the TAM III thermostat up to 80°C.

PRECISION TITRATION CALORIMETER

The Precision Titration Calorimeter is a single-position, semi-adiabatic calorimeter intended for use with the TAM III Thermostat. It provides high precision measurements of the heat generated or consumed when a solid or liquid sample is dissolved or diluted into a solvent. Utilizing the same configuration as the Precision Solution Calorimeter but with additional functionality, it is possible to inject small quantities of a solute into the stirred solution in order to investigate binding or complexation phenomena. Repeated injections can be performed by use of a syringe pump.

The Precision Titration Calorimeter is designed for highest accuracy and precision and is used in general thermodynamic investigations as well as for quantitative analytical measurements of various solid state phases.



TAM AMPOULES

TAM AMPOULES ARE USED TO CONTAIN THE SAMPLE IN THE CALORIMETER DURING MEASUREMENT. THE AMPOULES ARE OF TWO BASIC TYPES; CLOSED AND OPEN. IN THE CLOSED AMPOULES, NO MANIPULATION TO THE SAMPLE IS DONE DURING THE MEASUREMENT. IN THE OPEN AMPOULES, ALSO REFERRED TO AS THE MICRO REACTION SYSTEM, THE SAMPLE CAN BE MANIPULATED AFTER INSERTION INTO THE CALORIMETER.



DISPOSABLE CRIMP SEAL AMPOULES

Disposable ampoules are the most convenient to use since they can be thrown away after use and no cleaning is required. The crimp seal ampoule is perfect for experiments at lower temperature ranges. They are available in 3, 4 and 20 ml sizes.



STAINLESS STEEL AMPOULES

Available in regular stainless steel or hastelloy, these ampoules are used for samples that either react with glass, are to be investigated at high temperatures, or where it is suspected that a gas will be evolved during the experiment which increases the pressure in the ampoule. Ampoule lids are screw top and are available in 4 and 20 ml sizes.



HEAT SEAL AMPOULES

The heat seal ampoules are sealed by melting the glass at the top of the ampoule. These are recommended when rubber caps would be affected by gases or liquids involved in a reaction. The reactants are completely surrounded by glass. They are available for a maximum sample volume of 5 ml.



SOLCAL AMPOULES

These ampoules are used with the Precision Solution Calorimeter and are also referred to as crushing ampoules. They are made from glass with a volume of 1.1 ml. The most common SolCal ampoule is the crushing ampoule with stopper. This is preferably used for solid sample dissolution into water. The ampoule is sealed with a rubber stopper and wax. Heat seal crushing ampoules can be used if reactivity is an issue.

TAM AIR AMPOULES

20ML AMPOULES

All 20 ml closed ampoules currently available from TA Instruments can be used in the TAM Air Calorimeter. 20 ml ampoules are available in glass, stainless steel or HDPE (plastic).

The Admix Ampoule is available to initiate reactions inside the calorimeter and is configured with or without a motor. For suspensions such as mixtures of cement/water manual stirring is recommended. For liquid systems, a motor may be used for stirring.



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SALES & SERVICE

We pride ourselves in the technical competence and professionalism of our sales force, whose only business is thermal analysis, rheology and microcalorimetry. TA Instruments is recognized worldwide for its prompt, courteous and knowledgeable service staff. Their specialized knowledge and experience are major reasons why current customers increasingly endorse our company and products to their worldwide colleagues.



APPLICATIONS - PHARMACEUTICALS

STABILITY & SHELF-LIFE

TAM III can be used to obtain reliable stability measurements within hours and under near ambient storage conditions. Data can be obtained at conditions closer to ambient compared to other techniques such as UV-visible spectrophotometry. Furthermore, conventional stability screening methods such as HPLC often take several weeks or months to obtain reliable data. Thus microcalorimetry is particularly useful for quantifying very slow reaction rates, and there are numerous examples in literature that describe the use of TAM to obtain stability data. Figure 1 shows stability data for benzoyl peroxide. These experiments were performed in 16 hours and at a rate constant of 10^4 s^{-1} , which is equivalent to a half life of 22 years.

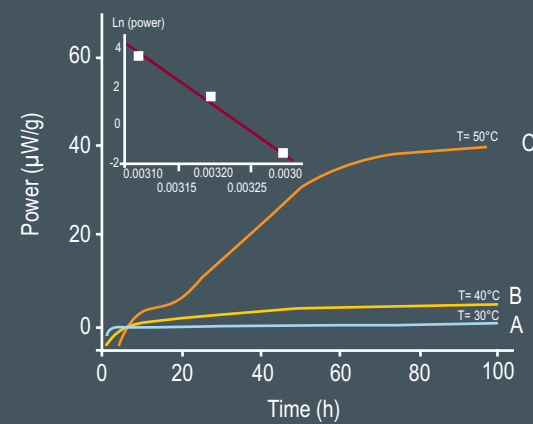
FIGURE 1

T(°C)	K(S ⁻¹) Microcalorimetry	kb(s ⁻¹)(UV)
20	$1.16 \times 10^3 \pm 3.74 \times 10^9$	
25	$4.33 \times 10^3 \pm 3.59 \times 10^8$	
30	$6.85 \times 10^3 \pm 1.33 \times 10^8$	
35	$2.00 \times 10^4 \pm 2.83 \times 10^8$	
40	$5.84 \times 10^4 \pm 2.53 \times 10^8$	
45	$1.07 \times 10^5 \pm 8.49 \times 10^9$	
55		$1.00 \times 10^5 \pm 1.50 \times 10^9$
70		$7.00 \times 10^5 \pm 9.92 \times 10^9$
90		$5.40 \times 10^4 \pm 6.00 \times 10^5$

PHARMACEUTICAL COMPATIBILITY

TAM III is an ideal screening tool for pharmaceutical compatibility trials. Like stability screening, compatibility screening can be performed at ambient temperatures and humidities without the need to dissolve or physically alter the sample prior to analysis. An experiment typically takes only a few hours as opposed to conventional HPLC which can take many weeks or months. The data in Figure 2 show the response of an amine-lactose interaction at different temperatures with 20% water added. The amine and lactose are very incompatible together. Only a small response was seen at 30 °C (A) with an increasing signal as the temperature of measurement is increased to 40 °C (B) and 50 °C (C). The inset Arrhenius plot confirms that all three temperature points fall on a straight line which is a strong indication that the same process is happening in all three experiments.

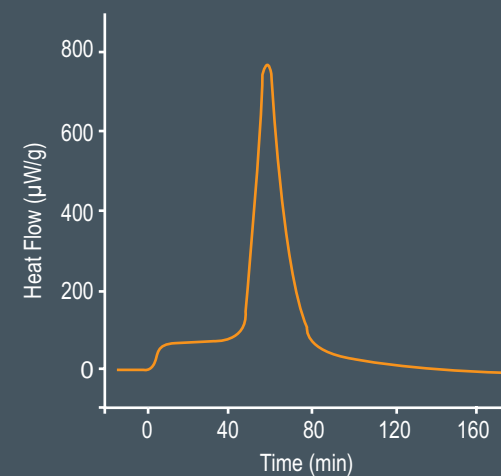
FIGURE 2



AMORPHICITY & CRYSTALLINITY

Micronization and processing can alter the surface properties of materials. Small amounts of amorphous material are often formed which may change the characteristics of the powder in a way that affects both processing and bioavailability. TAM III is an excellent tool for investigating low levels of amorphicity in a solid. The sample is loaded into an ampoule and then exposed to a solvent (usually water) vapor. The solvent lowers the glass transition temperature of the amorphous material enough to induce recrystallization, which is monitored as an exothermic response in the microcalorimeter as shown in Figure 3. By integrating the curve, the amount of amorphous material in the sample can be quantified to levels below 1%.

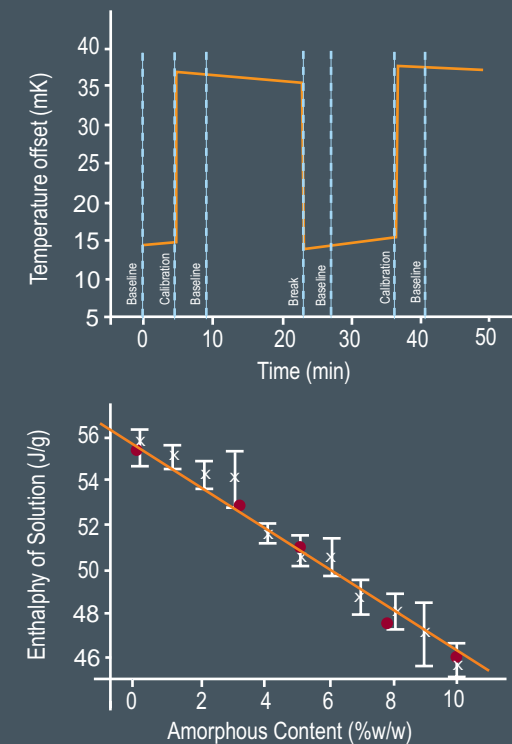
FIGURE 3



AMORPHICITY & CRYSTALLINITY

Solution calorimetry is an alternative to heat flow microcalorimetry in the assessment of amorphicity. This method works by dissolving the solid material in a solvent and measuring the temperature rise or fall in the solvent as a result of dissolution. Since amorphous and crystalline materials will have a different heat of solution, Solution calorimetry can be used to quantify the amount of amorphous material in a mixture of the two. The graph in Figure 4a shows the solution calorimetry data for a 5% amorphous fraction of lactose. The y-axis shows temperature offset from the bath temperature which was 25°C. The central "break" section shows the temperature decrease as a result of dissolving the sample in water. The other two steep transitions on either side are calibrations. Figure 4b contains a plot of amorphous content versus enthalpy of solution, and demonstrates the ability of the solution calorimeter to effectively measure amorphicity.

FIGURE 4

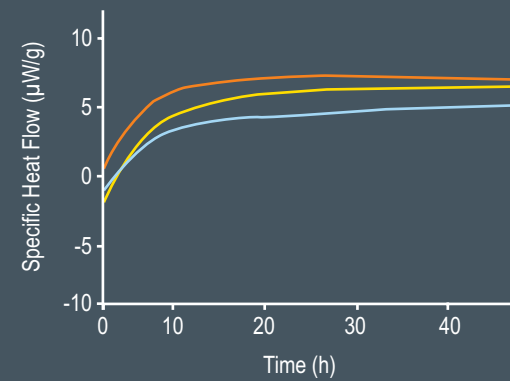


APPLICATIONS - MATERIAL SCIENCE

STABILITY TESTING-DETERGENT

Sodium percarbonate is manufactured in vast quantities around the world and is a major ingredient in washing powders and detergents. Unfortunately, sodium percarbonate is thermally unstable and undergoes continuous degradation. Figure 5 contains the results of stability tests on three separate samples using the TAM III at 40°C. This data demonstrates the relative stability of the samples based on the magnitude of the exothermic heat flow.

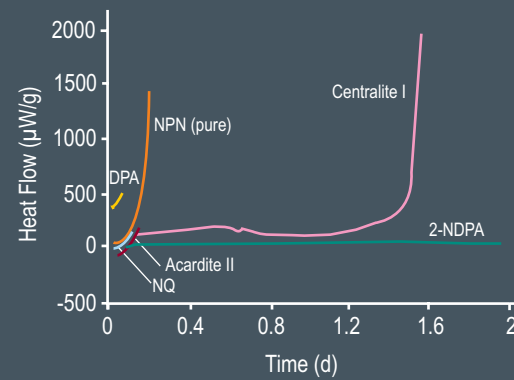
FIGURE 5



STABILITY TESTING-ENERGETICS

Some energetic materials need to be stabilized to improve the thermal stability. The degradation of these type of materials is associated with an exothermic heat flow which can be detected by TAM III. In the presence of an effective stabilizer degradation is prevented and the heat flow is low. Figure 6 contains a comparison of a variety of stabilizers with an energetic plasticizer. The time to the onset of a pronounced acceleration is termed the induction time and is a measure on how effective the stabilizers are to prevent degradation. This data suggests the 2-NDPA stabilizer is most effective.

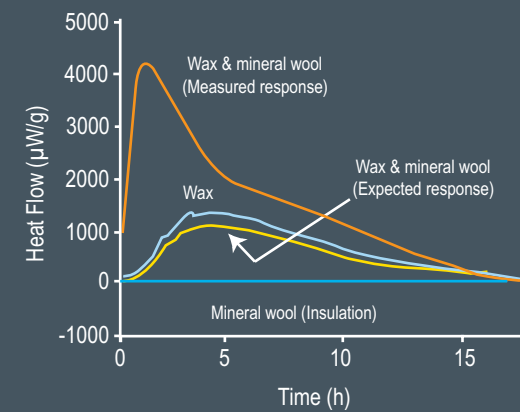
FIGURE 6



COMPATIBILITY

Compatibility testing is a kind of stability testing with reference to the constituents of a material. Microcalorimetry has proven to be particularly useful for compatibility testing; in some cases data is obtained after only a few hours. One example is the non-compatibility between wax and wool shown in Figure 7. The difference between the measured response and the expected response indicates incompatibility.

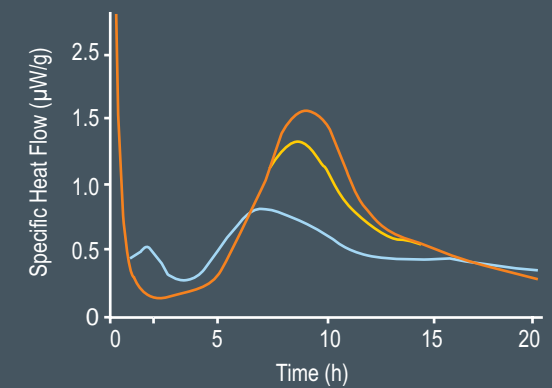
FIGURE 7



SETTING TIME OF CEMENT

The TAM Air calorimeter has been shown to be excellent for diagnosis of problems related to setting time and premature stiffening of cement. The blue curve of Figure 8 represents an industrial cement produced with too little soluble calcium sulfate. This cement suffers from early stiffening because of the aluminate reactions at 1- 1.5 hours hydration. It also suffers from low early strength, because the aluminate hydrates formed retard the strength-giving silicate hydration indicated by the unusually small silicate peak at 5-10 hours. When 0.5% (yellow curve) and 1.0 % (orange curve) of calcium sulfate hemi-hydrate was added to the cement the undesired early peak disappeared, and the strength giving silicate peak regained its normal shape. The results indicate that premature stiffening is caused by a lack of soluble calcium sulfate.

FIGURE 8



APPLICATIONS - LIFE SCIENCE

DRUG EFFICACY

Microcalorimetry has proven to be a sensitive and fast bioassay in cancer research to detect disorders of cellular metabolism. Figure 9 demonstrates a direct and dose-related effect on the heat flow after injecting a variety of concentrations of the anti-cancer drug methotrexate to cultured T-lymphoma tumour cells. Dose-response curves could be calculated for different cell lines from the thermograms.

The final drug concentrations were (a) 0, (b) 0.2, (c) 0.5, (d) 1.0, (e) 2.0, (f) 4.0 μM (ref 6).

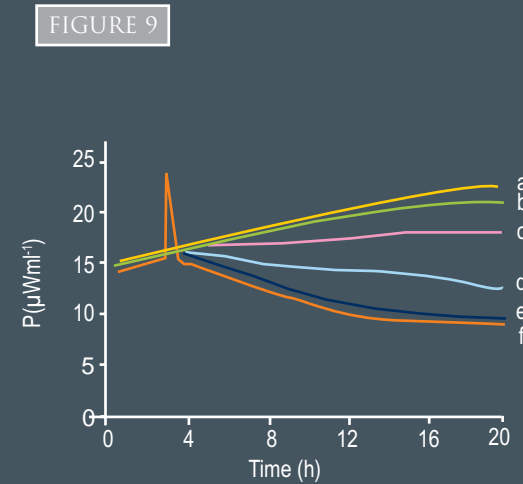
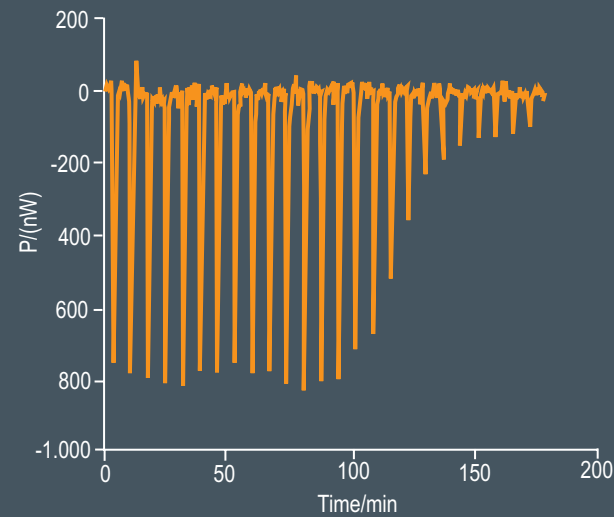


FIGURE 9

ISOTHERMAL TITRATION CALORIMETRY

Isothermal Titration Calorimetry (ITC) can be used to study molecular reaction and binding reactions in the pharmaceutical and life sciences fields. The data in Figure 10 contains an example of how the thermodynamic properties of the binding of Insulin Growth Factor I (IGF-I) to its receptor (IGF-I-rec) can be elucidated. The microcalorimetric titration binding measurements were performed at 25°C in saline HEPES and saline sodium phosphate buffer at pH 7.4. From this data, it is concluded that the biological response of the IGF-I-rec is due not only to the binding itself, but also to conformational changes incurred upon binding.

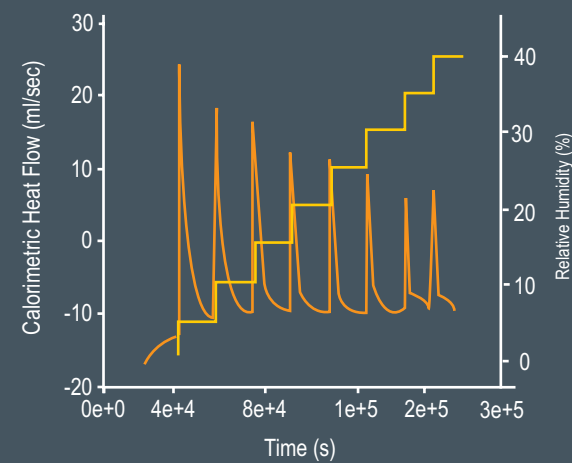
FIGURE 10



MOLECULAR INTERACTIONS

In food production and in the pharmaceutical industry, products can be damaged by freezing, drying and storage. While the mechanism for this process is still the subject of discussion, it is obvious that interactions between proteins and amorphous sugars reduce the water binding capacity, thus protecting protein sites that are sensitive to dehydration. RH Perfusion (hydration) calorimetry can be used to study the dynamics of water adsorption to native and saccharide-protected proteins or phospholipid membranes. The data in Figure 11 indicates the heat flow in μW when 2.1 mg initially dry lysozyme is exposed to a step-wise ramp in relative humidity ranging from 0 to 40 % using steps of 5 %.

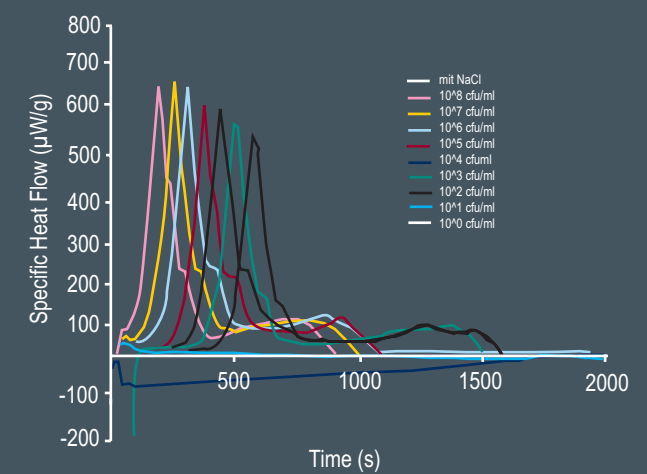
FIGURE 11



MICROORGANISM DETECTION

Identification of microorganisms in patient blood and donated platelet concentrates is essential in clinical practice to improve patient care and safety. Currently, commercial blood culture systems (detecting microbial CO_2 production by color change) are used for microbial detection in blood and platelet concentrates. However, these techniques generally require large samples and long evaluation times. Calorimetric detection of microbial growth may be more sensitive, simple and rapid than blood culture. The data in Figure 12 demonstrates how microcalorimetry can be used to detect metabolic activity in a platelet solution spiked with e.coli bacteria in a variety of concentrations, over a relatively short timescale. Applying this method to all donated platelet concentrates could reduce transfusion-related infections and extend storage time.

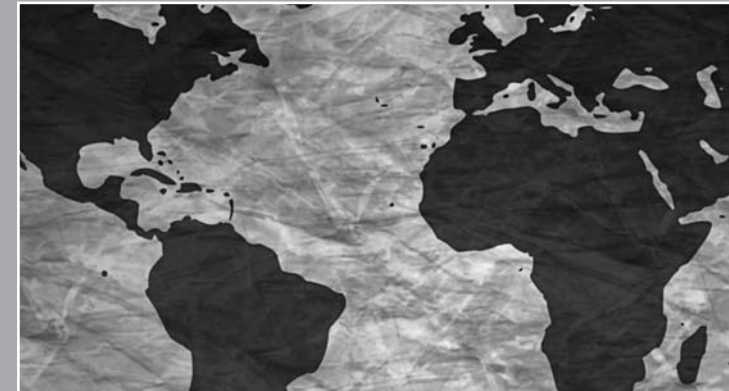
FIGURE 12



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TECHNICAL SUPPORT

Customers prefer TA Instruments because of our reputation for after-sales support. Our worldwide technical support staff is the largest and most experienced in the industry. They are accessible daily by telephone, email, or via our website. Multiple training opportunities are available including on-site training, seminars in our application labs around the world and convenient web-based courses.



NOTES

REFERENCES

FIGURE REFERENCES

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