ACOUSTIC ENVELOPE DETECTOR

See and Hear the Feeling...

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The Acoustic Envelope Detector System

When you bite into an apple, a sharp, crisp crunch tells you it's fresh. Without such a characteristic sound the apple would be less appealing. The science of sound emission is called acoustics and its analysis gives you vital information on the quality and acceptability of the food – both actual and perceived.

Over the last four decades, the sounds emitted during biting and chewing have been measured and studied to obtain more information on food texture. Perhaps the most salient characteristic of crunchy and crispy foods is the sound emitted upon their destruction during chewing or in mechanical testing. Now, acoustic emission measurement and analysis has been integrated into Exponent software, a recognised Texture Analysis software package. For the first time, the collection of acoustic data in 'real time' as an integral part of the texture test provides the **'4th Dimension in Texture Analysis'.**
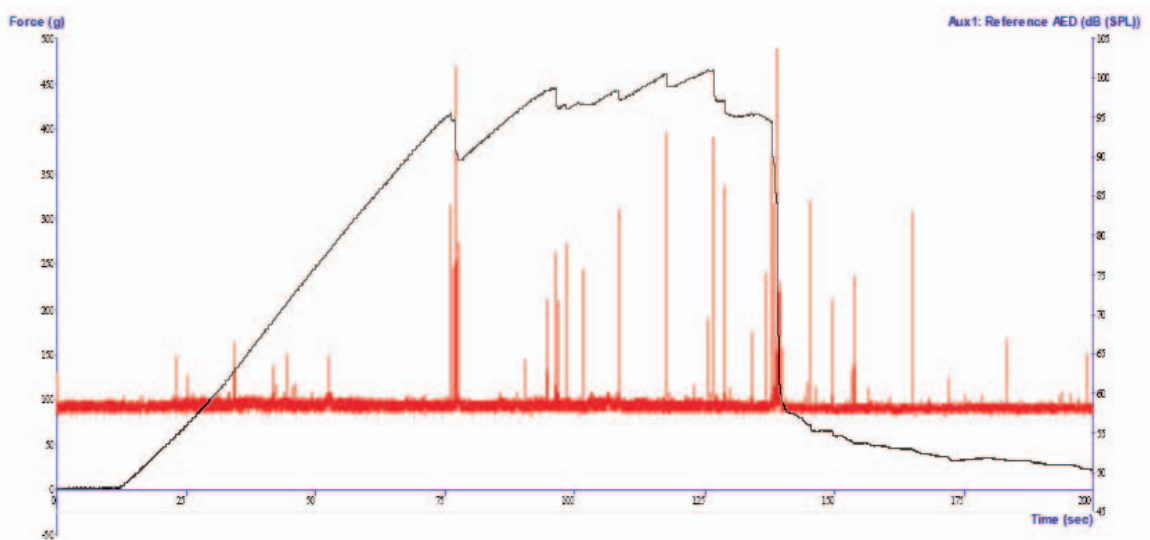
Figure 1 shows the synchronised and simultaneous display of force, distance, time and sound pressure level for breaking a biscuit

The Importance of Measuring Sound

Researchers and manufacturers accept that Texture Analysis makes a major contribution in the development and quality control of their products and processes. Early indications show that the addition of acoustic emission to give total 'Textural-Acoustic' analysis provides totally new data, as characteristics of the structure and behaviour such as crispiness are perceived as much by the sound emitted under stress as the force characteristics.

How does the AED Work?

The AED is an instrument that measures the acoustic energy released by a sample as it is being deformed and in conjunction with Exponent software converts and displays this in decibels (dB), the standard measurement of sound. Acoustic emissions, in the audible range up to a frequency of 12.5kHz are detected using a microphone that is placed adjacent to the sample. This information is converted into an analogue signal (voltage) that represents the total acoustic energy released from the product as it varies with time. This voltage is measured using one of the Auxiliary ports, while the TA.XT*plus* Texture Analyser simultaneously measures the force, distance and time.

It is important to understand that the AED measures the total voltage over the set frequency range and converts this into decibels. This is illustrated in **Figure 2** *below.*
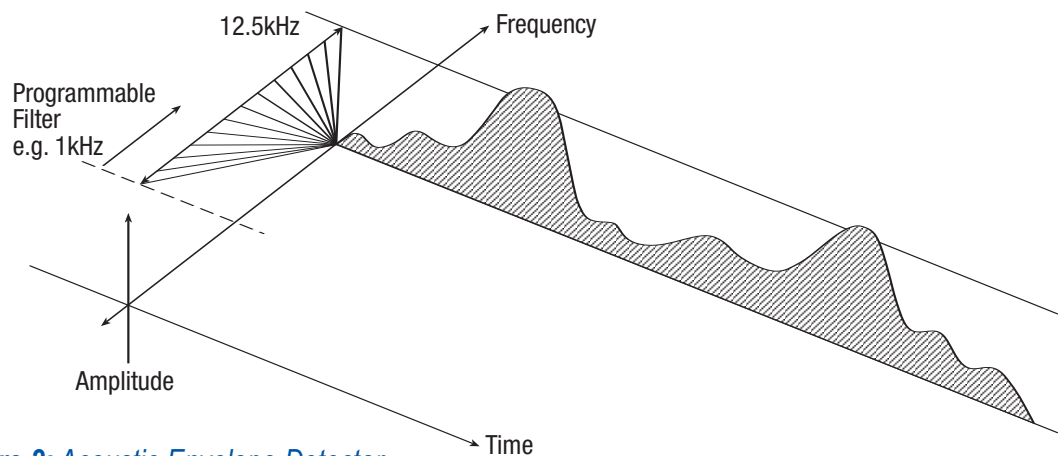
Figure 2: *Acoustic Envelope Detector –*
'1 frequency bin' from selected corner frequency to 12.5kHz

The AED uses a 1 'frequency bin' approach that measures how the total acoustic energy within the set bandwidth varies with time. To focus on a specific frequency band a high pass programmable filter can be adjusted within the *TA Settings* window to alter the breadth of the acoustic spectrum from the lower end. There are 9 settings range from 1kHz to 10kHz. *Note:* the factory standard is set to 3kHz to reduce background noise.

The advantages of this unique system are:

- Discrimination—unwanted background noise can be filtered out.
- Synchronisation—Force and sound traces from individual tests are automatically synchronised so the relationship between acoustic and force events can then be easily identified.
- Convenience—test data is saved as small files typically less than 200KB (dependent on length of test).

What about Background Noise?

The frequency of sounds emitted from crispy materials spread across a large frequency range, up to and beyond the upper range of human hearing. The background noise of the texture analyser and general laboratory is mostly below 3kHz and can therefore be ignored as it does not contribute to the characteristic of crispy/crunchy acoustic events.

Detailed research and analysis has enabled the design of a robust system that has low sensitivity to noise emitted by the texture analyser and general laboratories but a high sensitivity to the frequencies emitted by such crispy or crunchy products. This is effectively achieved by the use of the following:

- A high pass filter, easily configured by a drop-down menu in the test settings
- A directional microphone, mounted close to the sample
- Furthermore automatic macro's can be run on the data to assess the noise floor and a new data set can be generated without unwanted 'signal noise'.

The AED in action...

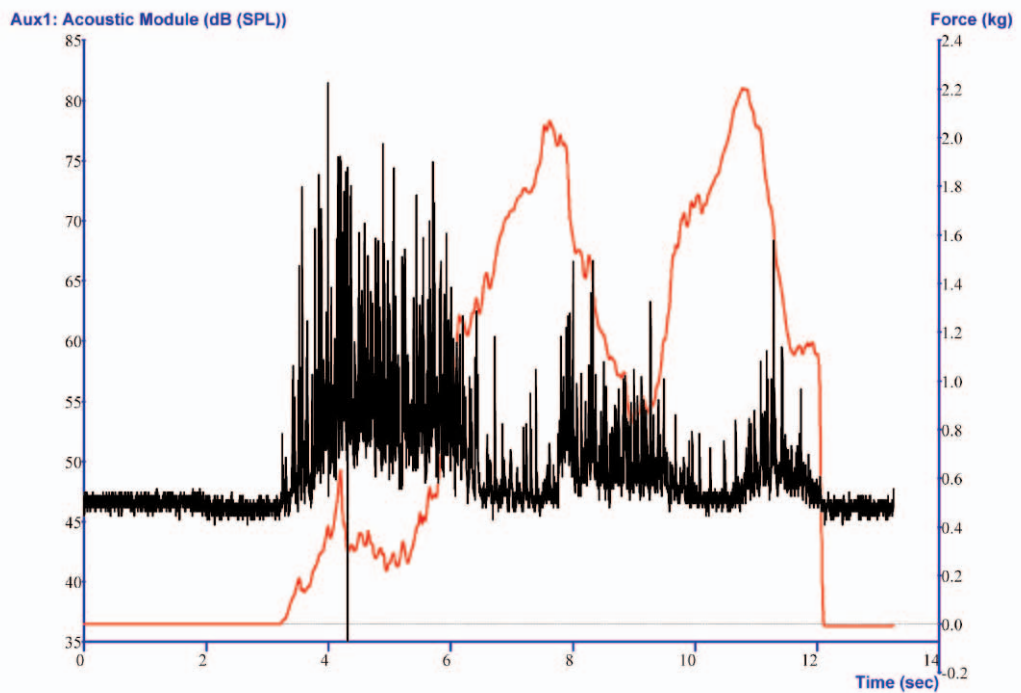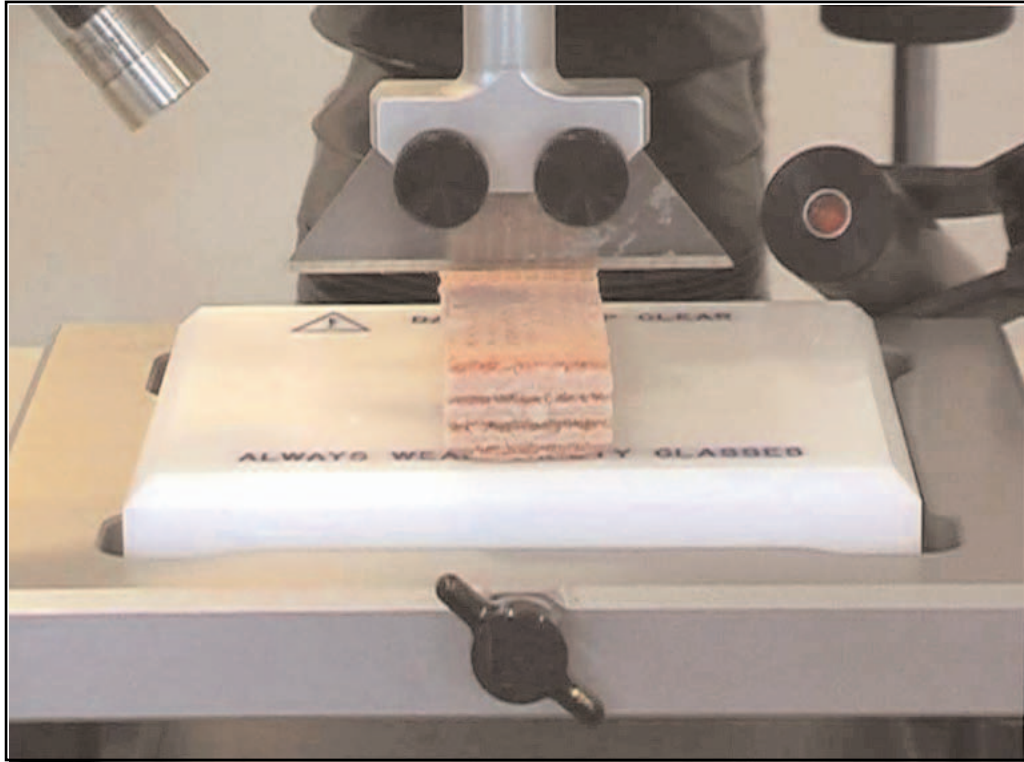The following pages give examples of various tests on food products.

The AED in action...
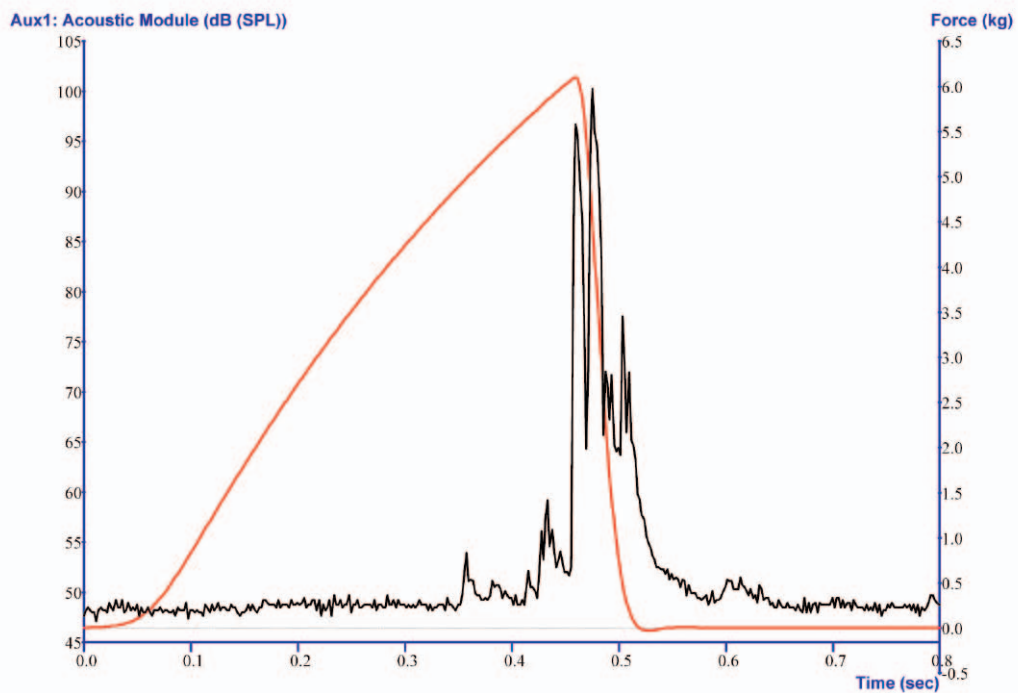
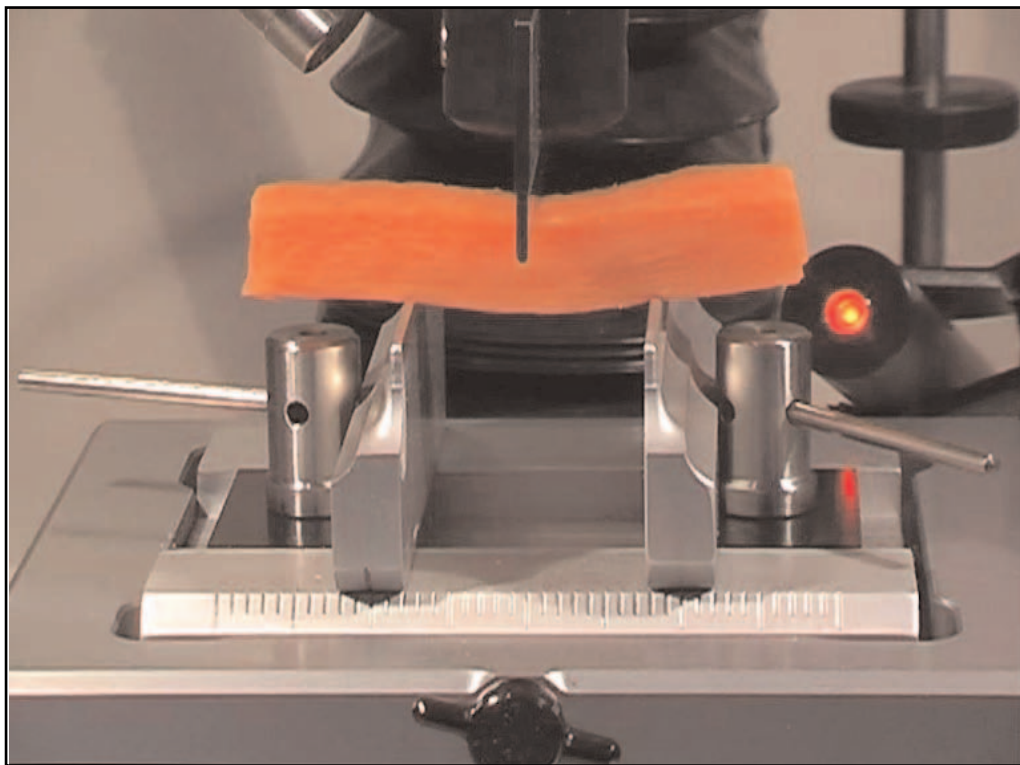**Click the image to hear a Tortilla Chip CRACK**
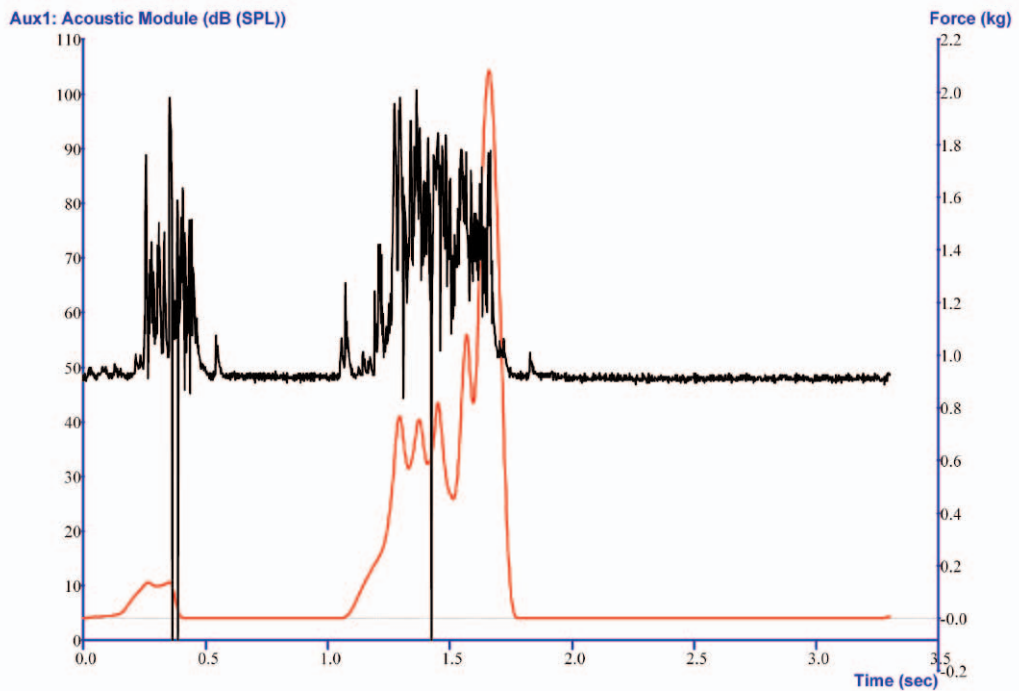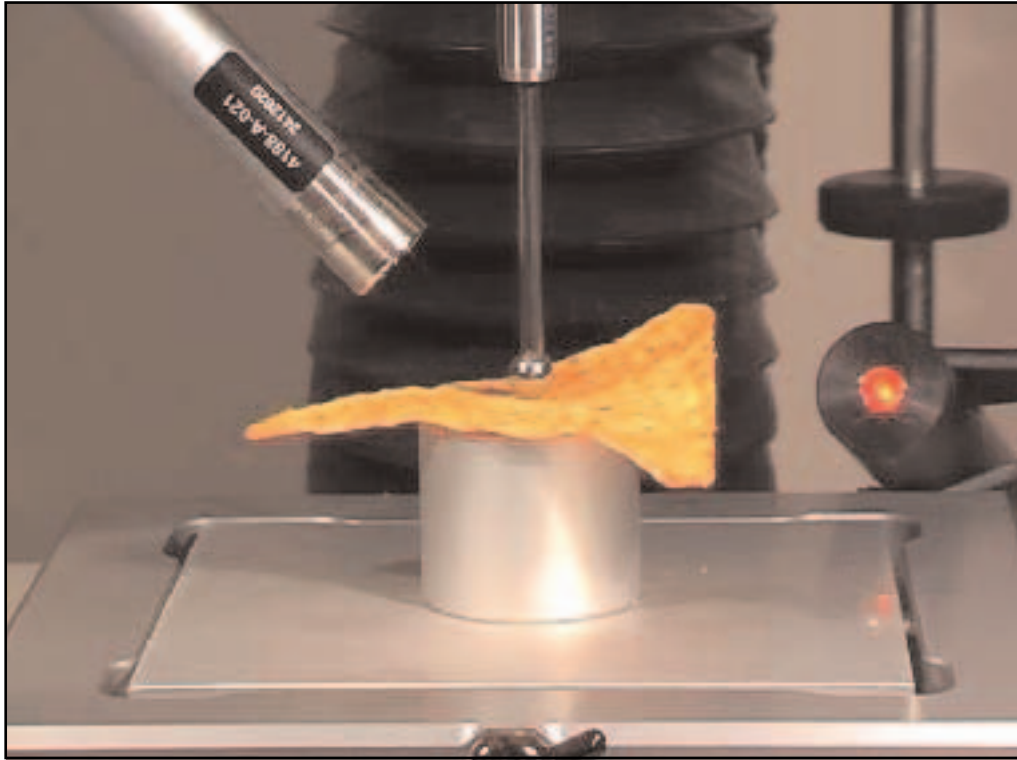
The AED in action...
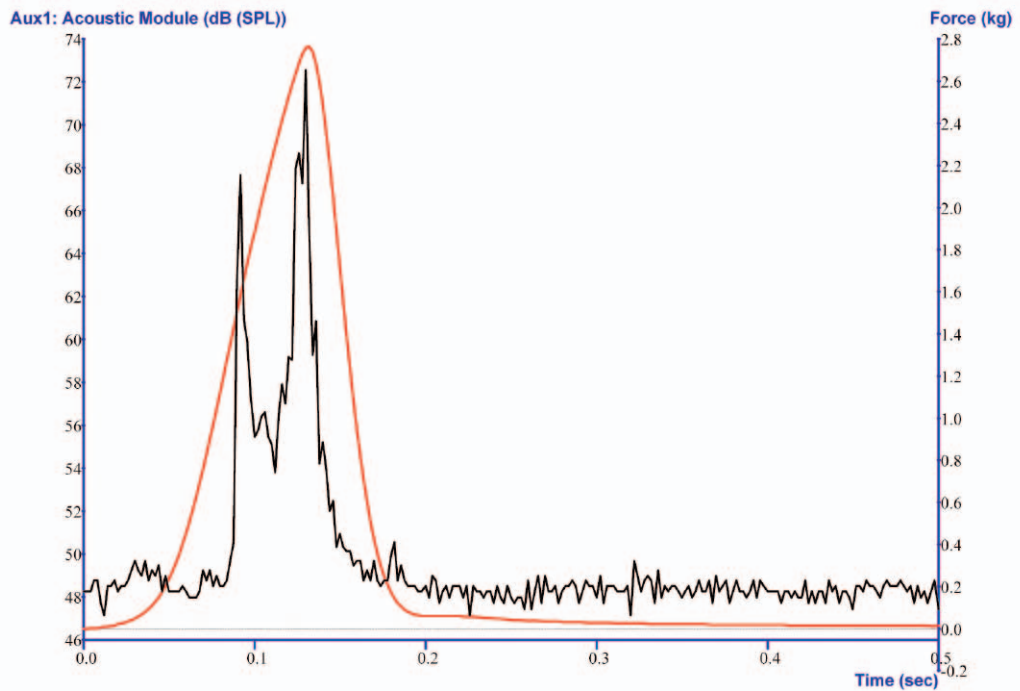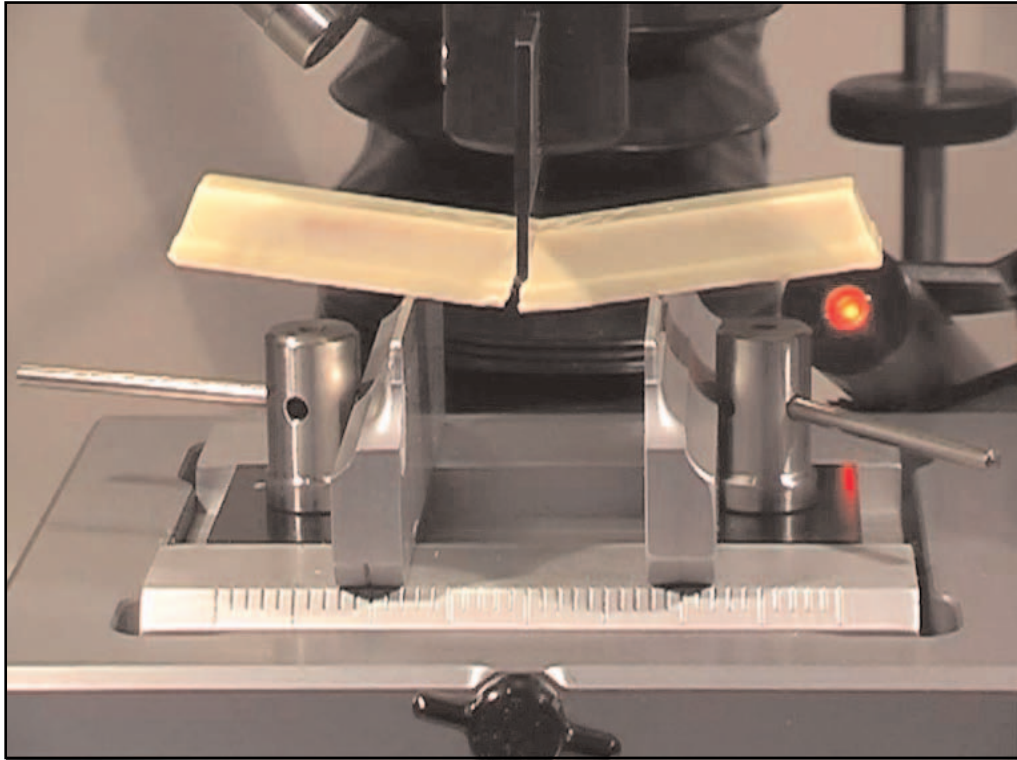
Click the image to hear a Wafer CRUNCH

The AED in action...
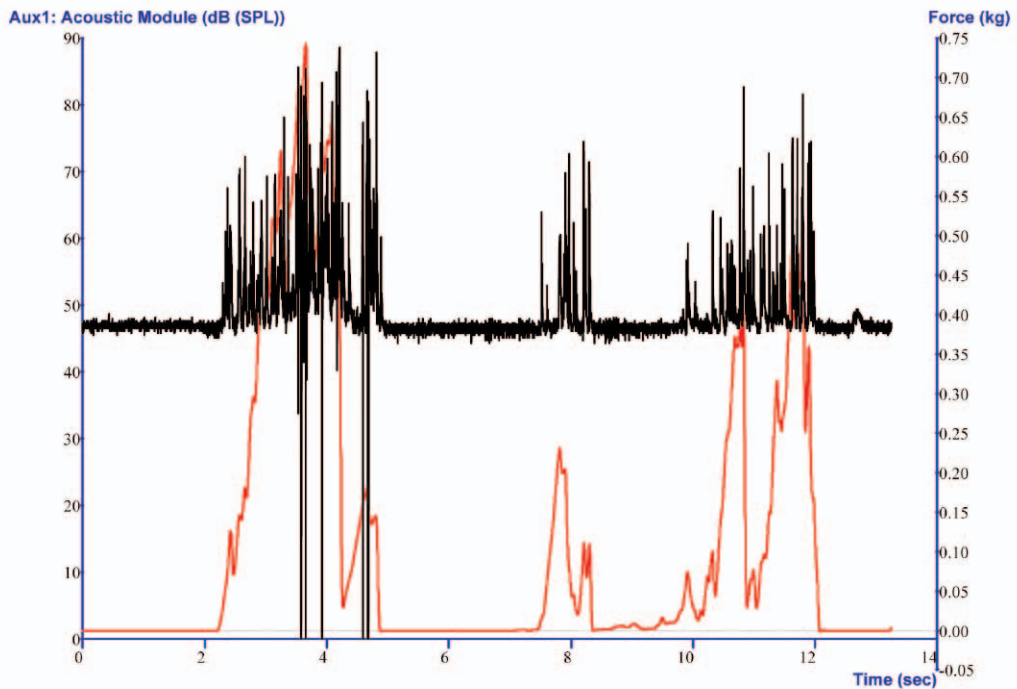
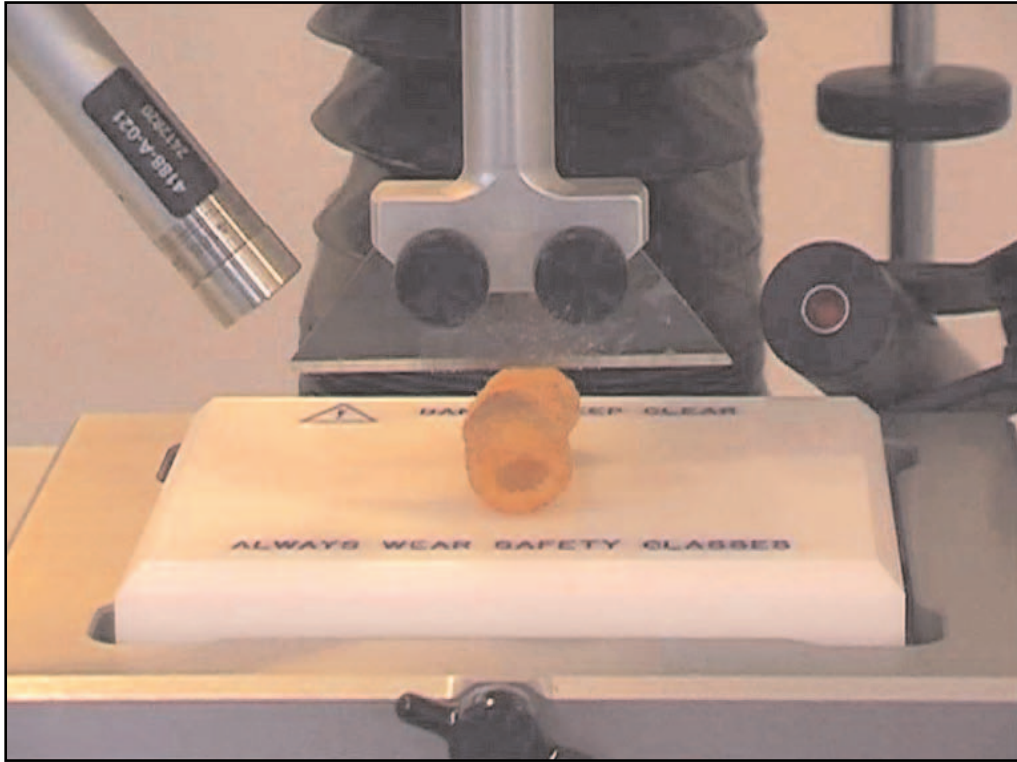**Click the image to hear a Carrot SNAP**

The AED in action...

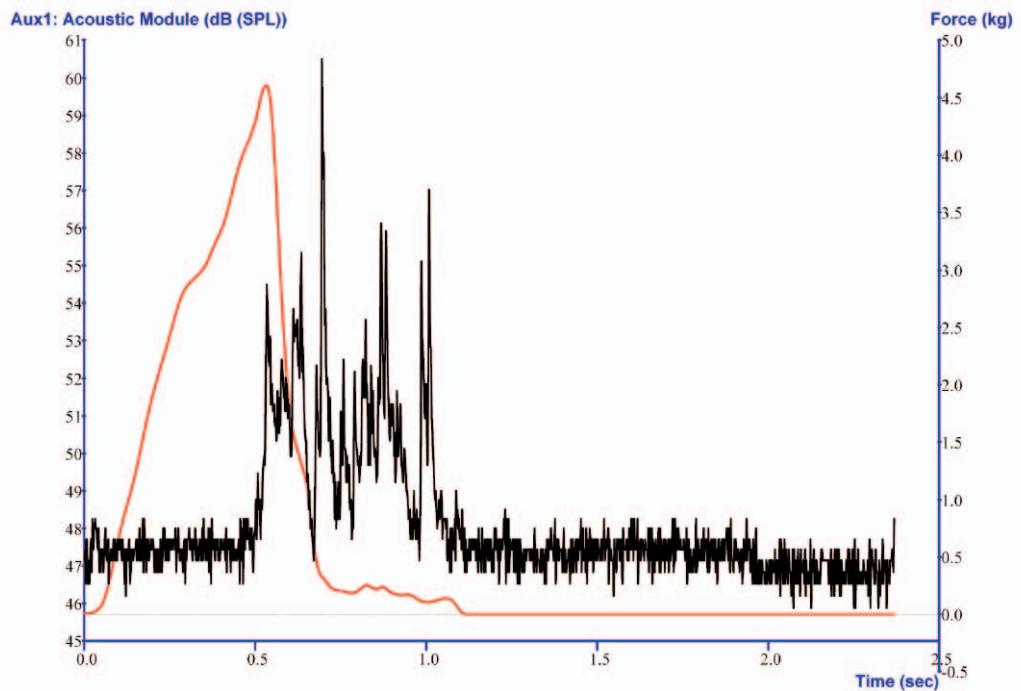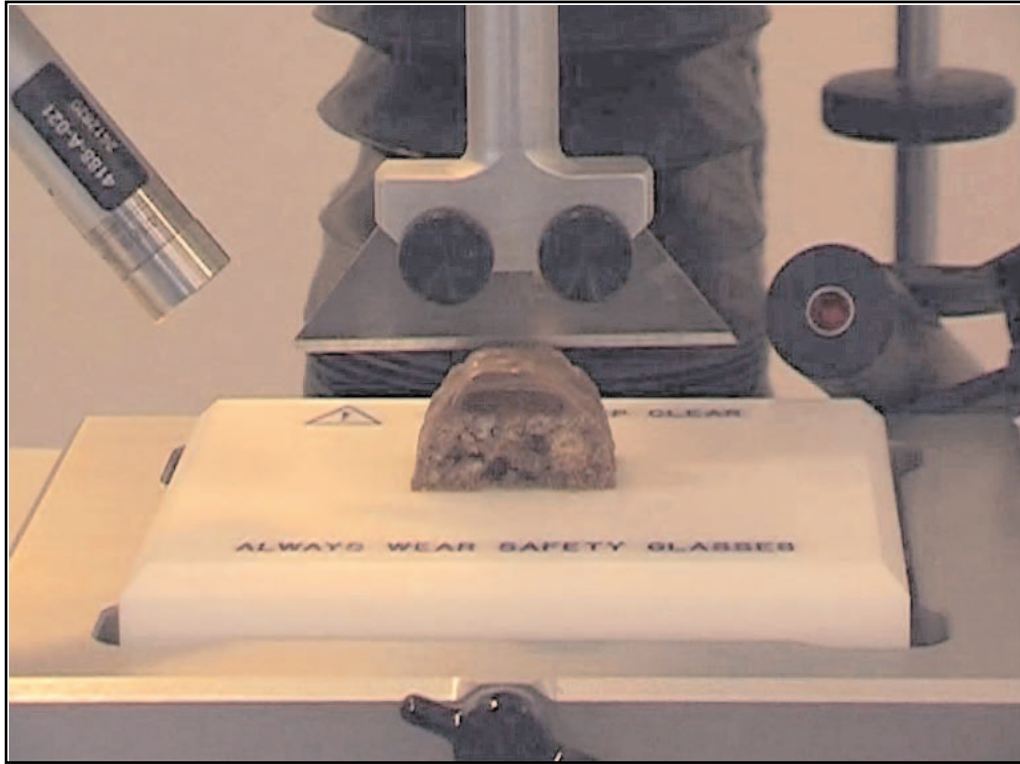**Click the image to hear a Chocolate Bar SNAP**

The AED in action...

Click the image to hear a Snack CRUNCH

The AED in action...

Click the image to hear a Layered Chocolate Confectionery Bar CRUNCH

Technical Specification

The reference system (A/RAED) uses a highly sophisticated and sensitive microphone which is calibrated by the user to National Standards. This means that fundamental acoustic data is obtained and therefore results obtained at different times, locations or from different units or systems can be compared directly and accurately.

	Reference System
Order Code	A/RAED
Acoustic Input Frequency range	1kHz to 12.5kHz
Acoustic Input Sound Pressure Level range	90dB to 114 dB SPL
Output signal voltage range	0v to 4.5 v
Output signal frequency range	D.C. to 250Hz
Texture Exponent Integration	Yes
Sound Pressure Level Calibrator	Conforms to IEC942(1988) Class 1 & ANSI S1.40-1984(R1997)
Measurement Transducer (microphone)	$^1/_2$" Prepolarised condenser transducer
Data sample rate	500pps

Stable Micro Systems