

Introduction to Acoustic Emission Sensors

AE sensors are used in a wide range of fields, including the inspection of manufactured products, monitoring the safety of structures, and the development of new materials.

What is AE ?

Acoustic Emission (AE) is the sound emitted as an elastic wave by a solid when it is deformed or struck. The use of AE sensors to detect these elastic waves and to non-destructively test on materials is called the AE method.

Quite some time before failure occurs, tiny deformations and minute cracks will appear and spread in materials. By picking up the trends in AE, the AE method can detect and predict flaws and failures in materials and structures.



Typical non-destructive testing methods

- ① Ultrasonic Testing (UT)
- ② Radiographic Testing (RT)
- ③ Eddy Current Testing (ET)
- ④ Acoustic Emission Testing (AET)

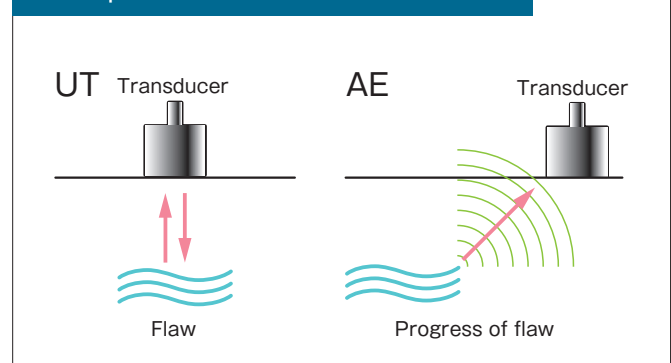


Features of the AE method

The AE method is used to detect frequencies in the ultrasonic range (several tens of kHz to several MHz). Although AE resembles ultrasonic testing, the AE method is different from other non-destructive testing methods in that it detects the dynamic energy that the flaws in the material themselves emit. The AE method offers the following advantages.

- Can observe the progress of plastic deformation and microscopic collapse in real time.
- Can locate a flaw by using several AE sensors.
- Can diagnose facilities while they are in operation.

A comparison of UT and AE methods



The principle behind the operation of the AE sensor

Except for special cases, PZT (lead zirconate titanate) is used as the detection element in AE sensors. Other materials, such as lead niobate and lithium niobate are available; however, their sensitivity is far lower than that of PZT and their applications are limited to special environments such as high temperatures.

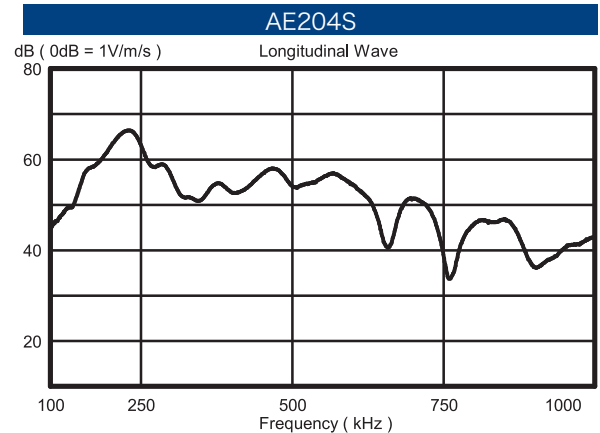
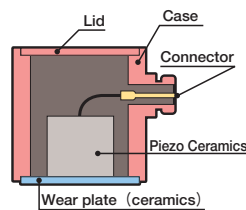
PZT and other piezoelectric materials generate an electrical charge when subjected to a force. AE waves propagating along a metal or other surface are transmitted to the PZT inside the AE sensor, and the deformation of the PZT is converted into an electric signal.

The structure and features of AE sensors

AE sensors are broadly classified into two types: resonance models (narrow-band) that are highly sensitive at a specific frequency, and wide bandwidth models that possess a constant sensitivity across a wide band of frequencies. The choice of model depends on the goal of the application.

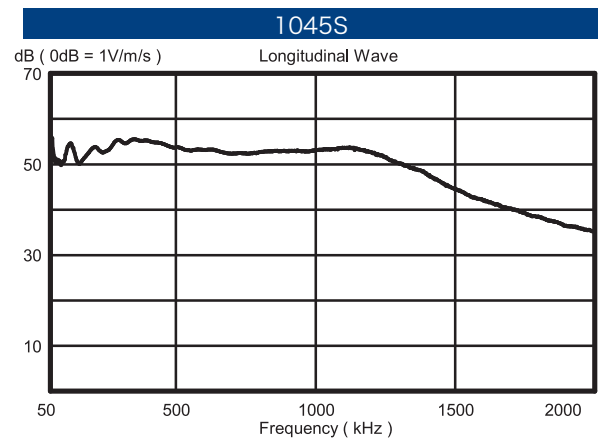
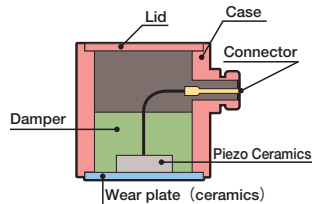
Resonance model

The mechanical resonance of the detector element is used to obtain high sensitivity. Generally, these types of sensors have resonant frequencies in the range of 30 kHz to 1 MHz. AE sensors having a piezoelectric accelerometer design are used if lower resonance characteristics are required.



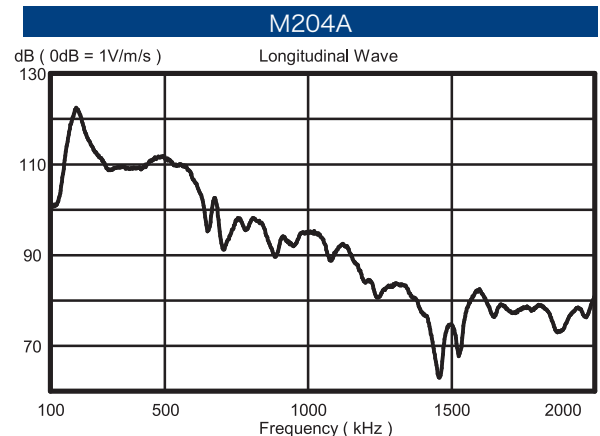
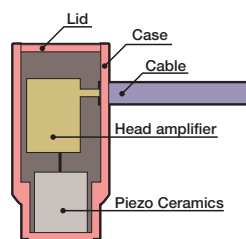
Wide bandwidth model

A damper is bonded on top of the detector element to suppress the resonance.



R-CAST TYPE

This design incorporates a head amplifier and a special pre-amplifier to yield high sensitivity with low noise levels. Compared with other models, the sensitivity (S/N ratio) is at least twice as high.



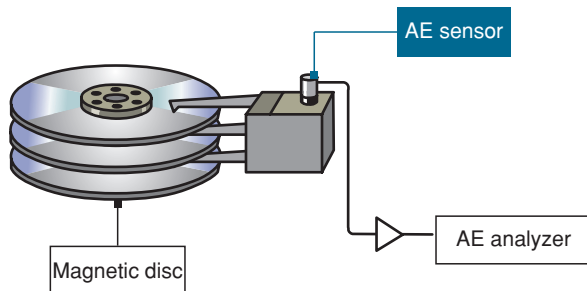
The application of AE sensors

AE sensors can pick up warning signals from manufactured products that human senses cannot detect. AE sensors have a wide range of applications, from quality control inspections of manufactured goods, to safety inspections of large structures.

Product testing

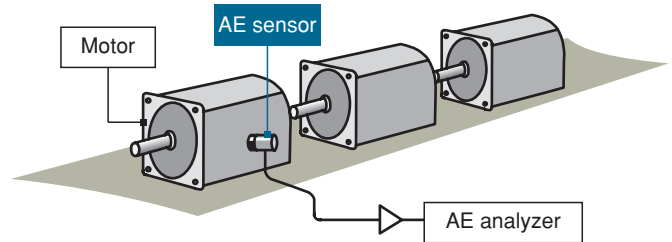
■ Detecting event of "head touch" in magnetic discs

AE sensors are used in the quality control management of magnetic discs. The sensors can detect the sounds of tiny prominences on a rapidly spinning magnetic disc striking the magnetic head.



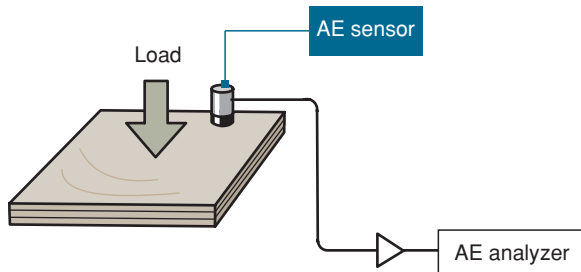
■ Detection of abnormal sounds in small electric motors

The passing or failure of the product can be decided based on the level of abnormal sounds coming from motors and fans.



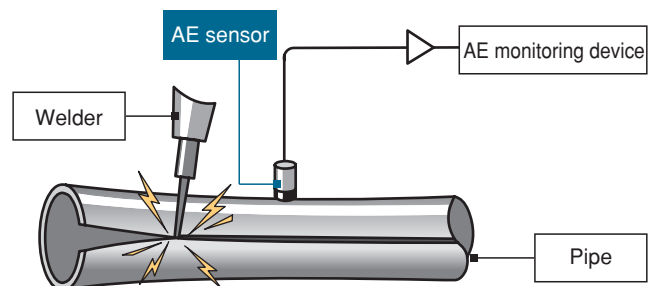
■ Inspection of the bonding of laminated boards

An AE sensor can tell by the acoustic emissions generated when a load is applied to a laminated board whether there is poor bonding between laminations or not.



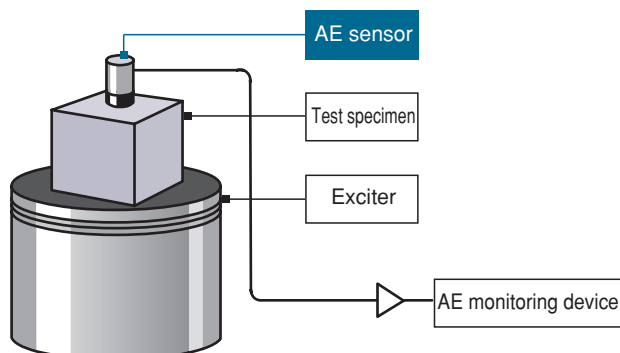
■ Detection of sub-standard pipe welds

When pipes, etc., are improperly welded, the substandard welding can be detected by the AE that are generated.



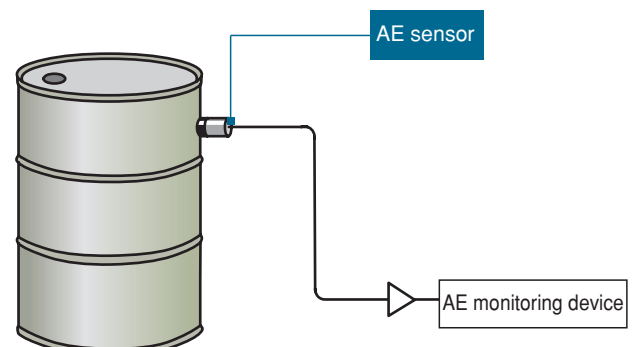
■ Detection of foreign bodies in manufactured products

Can detect the sounds of solder scraps and other waste striking the walls inside manufactured goods.



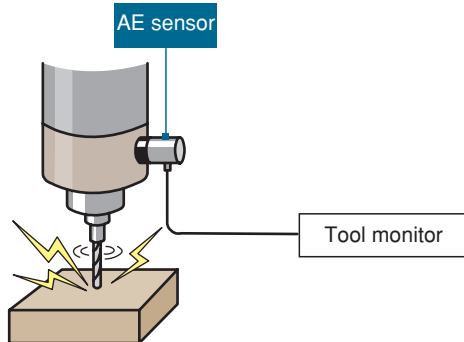
■ Detection of tiny hole in drum cans

The passing or failure of the drum can be decided by leak detection when air is pumped into the drum.



Tool monitoring

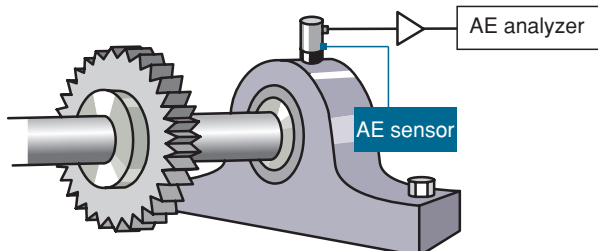
Detects the instant that the whetstone touches the work. This is useful in the improvement of product quality by controlling the speed of the whetstone and detecting damage to the tool.



Facility diagnosis

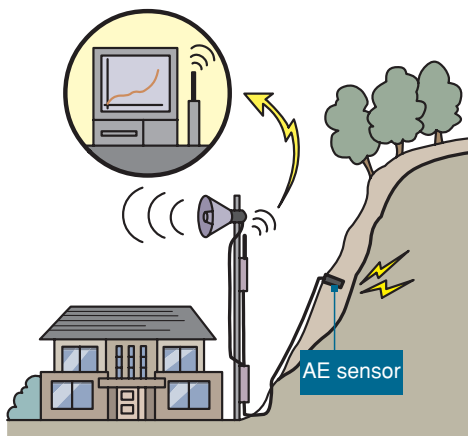
AE sensors are used in the facility diagnosis of rotating machinery.

They are particularly effective in the diagnosis of machinery rotating at slow speeds.



Safety monitoring in civil engineering projects

Detection of the sounds that occur before landslides, or signal the occurrence of cracks in tunnels and other underground spaces.

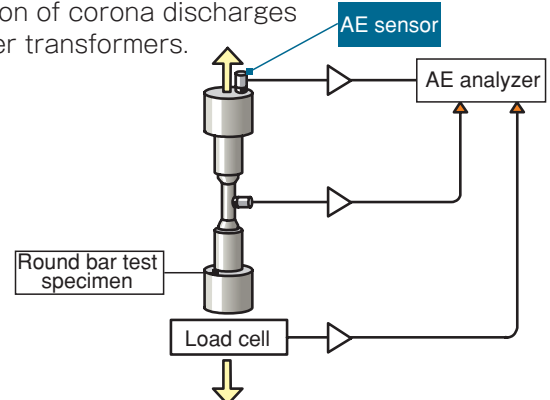


Material testing / other applications

Tensile testing and fracture toughness testing.

Detection of quenching in superconductivity.

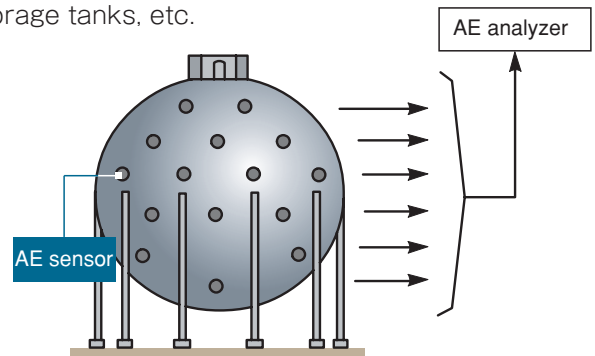
Detection of corona discharges in power transformers.



Diagnosis of the integrity of large structures

Monitoring for cracks in pressure vessels, bridge piers, rolling mill stands, etc.

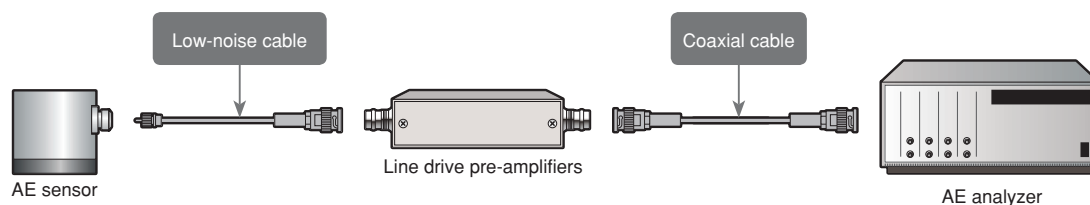
Detection of the sound of leaks in pipes, valves, storage tanks, etc.



Examples of measuring system

The following two system combinations are available depending on the type of acoustic emission sensor.

● Amplifier not built-in type



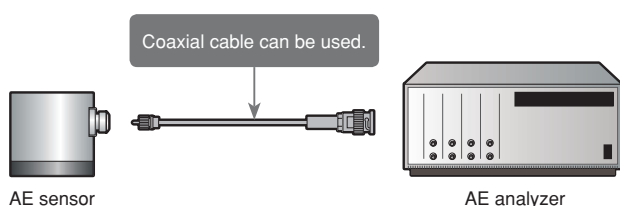
A preamplifier is used to amplify acoustic emission (AE) signals, which are very faint in nature. At the same time, filters are used to eliminate unnecessary signals.

A low-noise cable is required to connect a sensor to a preamplifier.

■ AE preamplifier A20S-BB

Gain	20±2dB	Size mm		Power supply	
Frequency range	20~2000kHz				
Output impedance	75Ω				
Maximum output voltage	1V _{P-P}				
Power consumption	≤15mA				
Temperature range	-20~+80°C				
Power requirement	15V (load 75Ω)				
IN/OUT connector	BNC				
Weight	70gm				

● Amplifier built-in type



An ordinary coaxial cable can be used for AE sensor with built-in amplifier. In such cases, users should identify the operating conditions specified for the sensor drive power source that comes from the AE analyzer before use.

■ Specification of amplifier inside the sensor

Gain	40dB	20dB
Power requirement	28V (load 50Ω)	15V (load 75Ω)
Applied model	SA40 type sensor	1045SWA

