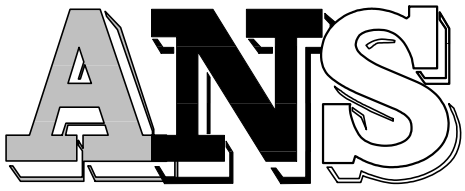
Les technologies



Technologies

WEAR
•
EROSION
•
CORROSION

Real-time monitoring of material losses
using
Surface Layer Activation

Surface Layer **A**ctivation Technology

The efficiency and reliability of machine parts and industrial equipment is significantly affected by wear and corrosion.

A reliable and on-line measure of wear and corrosion can result in substantial savings in time and money during the development of machine components and lubricants, or static parts subject to corrosion. Moreover, on-line monitoring may be used to minimize costly downtime and unscheduled interruptions during a component's lifetime.

For this reason, ANS offers a complete industrial service based on Surface Layer Activation (SLA), aka Thin Layer Activation (TLA), which is far superior to traditional techniques for monitoring wear and corrosion in the development of mechanical components and the maintenance of critical parts.

A thin layer and pre-selected area of the surface of the component is labeled with radio-isotopes. This is done without significantly affecting the mechanical or chemical properties of the part. The activity so created is extremely low and poses no hazard to staff. Once the activated part has been installed and the machine reassembled, specific measuring equipment can detect the gamma rays emanating from the induced activity.

During the wear or corrosion process, the loss of material results in a loss of activity at the surface of the part and an accumulation of activated particles in the lubricant. By placing a gamma ray detector near the activated component or near the lubricant circuit reservoir or filter, the movement of the activity is very precisely measured. These measured values are computer-processed rapidly, and the on-line monitoring of the degradation is delivered by a user-friendly software in a comprehensive and informative manner.

SLA technology represents a significant breakthrough for industry. The system is able to deliver a non-contacting and continuous measurement of wear and corrosion, even for parts at inaccessible locations. The results are extremely precise (0.1 µm - 0.01 µm). Moreover, the exact location of the loss is known. The measurements are performed under real operating conditions, and our system is capable of monitoring and recording critical operating parameters along with the degradation data.

Main Features		***Your Benefits***
Very high sensitivity	⇒	Faster development
On-line measurements	⇒	Dynamic studies
Selective labeling	⇒	Exact localization of wear
Remote measurements	⇒	Study inaccessible locations

1. Application of the SLA Technique

The SLA technique is applied in three steps:

1- PRELIMINARY STUDY
2- LABELING WITH RADIOISOTOPES
3- MONITORING OF WEAR OR CORROSION

STEP 1: PRELIMINARY STUDY

The Thin Layer Activation technique is applicable to nearly all cases of material loss analysis, provided that the particles detached from the labeled zone are removed from that zone. A short analysis is typically required for each application, since the technique is customized for each situation. Because the customer's engineers have the finest expertise when it comes to their machines and their test benches, we want to collaborate with them in the design of each measurement so that optimum results can be obtained.

- **Location of the critical wear area**

After discussions and analysis of the wear problems encountered by the customer, the critical wear area is determined. The area to be activated is then chosen. Many different possibilities are available to maximize the sensitivity of the measurement. This area can be in the shape of a dot, a line, a rectangular or circular area and may even be a circular band on the surface of a cylinder.

- **Composition of the component**

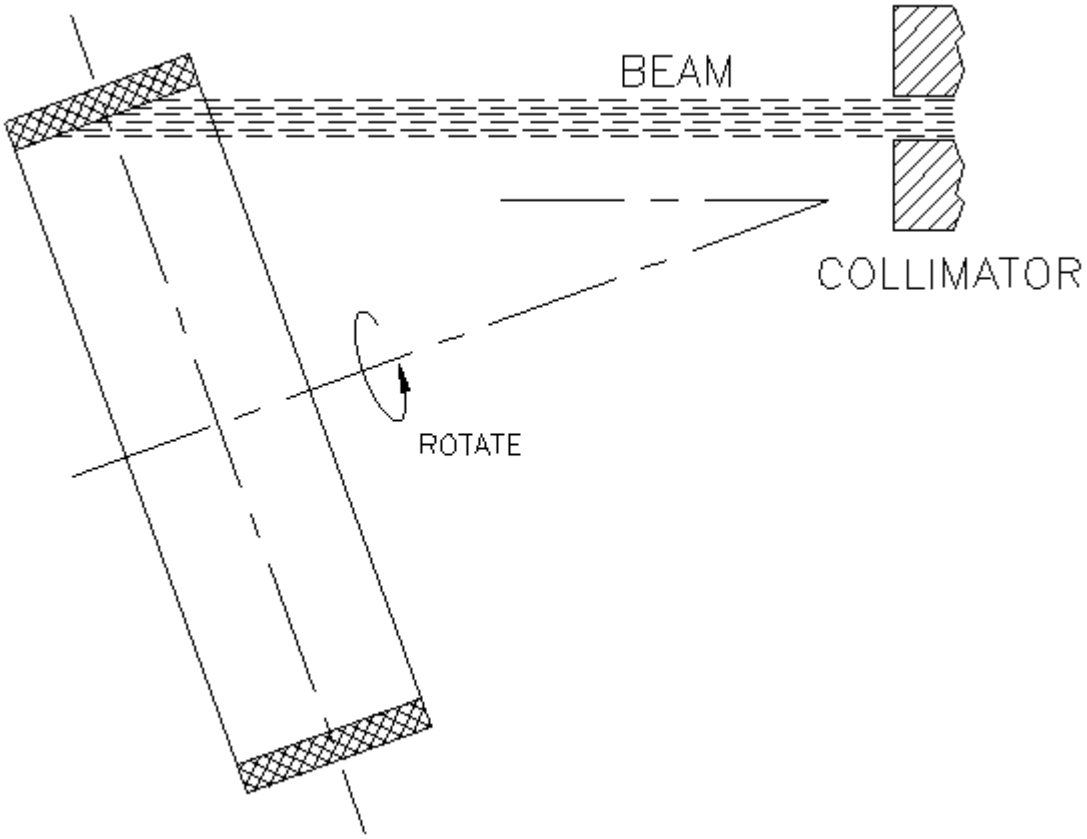
The isotope to be produced are chosen from the possibilities offered by the elements which make up the component. It is possible to activate most materials used in the industry, in particular, all iron-based alloys and materials that contain Nickel, Copper, Chromium, Molybdenum, Cobalt, Aluminium, Lead, Tin, Vanadium, Tungsten, Zinc and Magnesium. In the case of ceramics, adequate irradiation procedures of Al_2O_3, SiC, Si_3N_4, ZrO_2, TiC, TiN, cermets and various coatings are now available.

- **Expected wear depth**

The depth of the wear that is expected needs to be taken into account when the irradiation conditions are determined, in order to maximize the precision of the measurement. The depth of the activated layer is adjustable from 10 µm to 2 mm.

STEP 2: LABELING WITH RADIOACTIVITY

The labeling of a material is done by an ion beam from a particle accelerator, directed onto the surface to be studied. The beam particles have a certain probability to interact with atomic nuclei in the material and transmute them into a radioactive isotope. Only a very small fraction of the atoms in the material are transmuted (of the order of 1 in 10^{10}). The isotope produced during the labeling process is selected in order to optimize the measurement parameters. The depth to which the material can be activated is dependent on both the energy and angle of the incident ion beam. The quantity of isotopes created (the activity level) is precisely controlled by the ion beam intensity and the activation duration.



Labeling of a Bearing

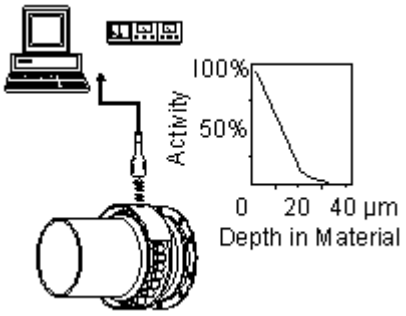
A very thin layer of the component is activated with a beam of accelerated particles

STEP 3: MONITORING OF WEAR OR CORROSION

The measurement of wear is achieved by detecting gamma-ray emissions from the activated material. These emissions are measured with gamma-ray detectors, such as Sodium-Iodide (NaI) or high-purity Germanium (HPGe). Two approaches are available, each with its own particular strengths:

- **THE RESIDUAL METHOD**

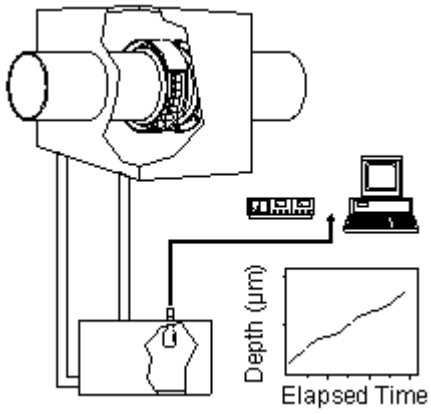
This method (also known as the Thin Layer Difference Method) consists of placing the detector near the activated component's labeled zone. The activity can be detected through intervening material up to a few centimeters thick (for steel). As the activated material is removed from the zone, the activity decreases. This variation of activity is then converted on-line into the equivalent material loss. This method has the advantage of being self-calibrating.



The measuring system detects the decrease of activity due to the loss of material from the labeled area.

- **FLOW-THROUGH METHOD**

This method is used when the wear particles can be collected in a lubricant circuit. Two different approaches are possible at this point: either the amount of activity in suspension in the lubricant is monitored, or the wear particles are captured by a filter or a magnet. The objective is to measure the activity from the particles in the lubricant, away from the activated component. As the activated material is collected in the lubricant, the activity increases. This variation of activity is then converted on-line into the equivalent material loss. This method has the advantage of being very sensitive.



The measuring system detects the increase of activity in the lubricant or coolant.

2. Main Benefits of SLA

- **ON-LINE MONITORING**

This technique has the advantage of permitting to carry out a non-contacting continuous measurement of wear or corrosion under real operating conditions. It enables the user to gather important information on wear kinetics and relate it to various operating parameters. This can be achieved in a single test, and thus minimize costly downtime and unscheduled interruptions. By providing a real-time information on the status of critical components, the technique provides a considerable insight which can help to optimize maintenance programs and get a better knowledge of the useful life of a component.

- **VERY HIGH PRECISION**

SLA measurements offer exceptionally high precision resulting in significantly shorter measurement times. The system enables the detection of surface losses as small as 0.01 μm in some applications.

- **EXACT LOCALIZATION OF WEAR**

Unlike other tribological techniques, SLA permits the selection of a very well defined area to be monitored on the component. This way, the wear of a single component of a system can be followed, without recording the overall wear condition emanating from other parts.

- **APPLICABLE TO A WIDE RANGE OF MATERIALS**

This technology makes it possible to study the wear behavior of new materials and ceramics. Because of their non-magnetic properties and high wear resistance, these materials require very precise measurements that can only be achieved SLA.

- **MULTIPLE POINT MONITORING**

Within the same system, the wear behavior of several parts can be studied simultaneously. For instance, a typical application is to monitor simultaneously the wear of a cylinder liner and its related first piston ring to get information on the "gusset wear".

- **HARD TO ACCESS COMPONENTS**

Thin Layer Activation permits the evaluation of material losses for components with a geometry which does not permit the use of other more traditional methods. The technique also permits the *real-time* monitoring of components situated within complex systems where they are mostly inaccessible.

3. Industrial Applications

SLA technology reduces significantly the number and duration of tests and thereby saves considerable amounts of time and money on recurrent studies and inspection procedures. Therefore, it is an economical and extremely efficient way of mastering wear and corrosion in any industrial application, provided that the wear particles are removed from the labeled zone.

- **Automobile Industry**

The automobile industry is one of the principal users of the Thin Layer Activation technique. The benefits include precise and rapid information, and therefore considerable reduction of time for engine part development. Typical applications include the wear and corrosion behavior of cylinder liners, piston rings and grooves, valve seats, camshafts, shaft bearings, fuel injection pumps, gear wheels, etc.

- **Aeronautic Industry**

Strict safety specifications lead to long testing periods in this sector. SLA leads to faster development, thanks to its very high sensitivity, on-line measurements and exact localization of the degradation. Typical applications include tests of roller bearings, universal joints, ball joints, gear teeth, pump vanes, air channels and turbine blades.

- **Chemical & Power Industries**

Significant benefits are achieved using the Thin Layer Activation technique in the Chemical and Power Industries. Corrosion failures can result in costly downtime, inspection or dismantling procedures. The installation of activated probes in pipes, for example, is a particularly efficient and reliable method to monitor, *in situ* and on-line, the corrosion behavior of critical areas. The measurements are performed under normal operating conditions and in hostile environments.

- **Lubricant Industry**

SLA accelerates significantly the development of new lubricants and additives. Continuous monitoring offers the possibility of changing critical parameters during the same measurement in order to directly study their influence on wear or corrosion processes.

- **Ship and Rail Industries**

SLA has been used to measure the wear of components from many types of engines. The wear of railway wheel steering rim has also been studied.

- **Mechanical and New Materials Industries**

In any field where the loss of material must be precisely quantified, Thin Layer Activation proves to be the most efficient method. This includes development or monitoring of parts from combustion engines, turbines, brakes, knitting machines, boring machines, as well as materials research and development of new ceramics and coatings.

4. SLA Services from ANS Technologies

In order to make the benefits of this technique available to a wide array of industries, ANS offers a full range of services:

- **FULL SERVICE PACKAGE**

In a standard application, the service includes the preliminary study, activation and monitoring. The customer need only assist in the preliminary analysis, installation of the activated component and operation of their specific equipment. The monitoring system is brought on site, installed and operated by qualified ANS personnel. After the experiment, a full analysis is completed and a written report is sent to the customer.

- **ROUTINE APPLICATION**

ANS also supports the customers interested in using the technique on a more regular basis. In these cases, ANS offers on-site training of the customer's personnel, activation of the needed components and/or provision of the Track-Wear monitoring system (rental or sale). Maintenance applications are typically of a longer duration. We can assist in the integration of the monitoring system to the customers equipment. In these cases, ANS remains available to the client for problem-solving, data analysis, interpretation of the results and the design of new applications.

- **OFF-LINE APPLICATIONS**

Off-line applications can be performed for interested customers. ANS performs the activation of the needed components and sends them back to the customer. Once the experiment is completed, the components are sent back to ANS. Residual measurements are made and the results are fully described in a written report.

- **FULL ASSISTANCE FOR LOGISTICS AND LEGAL AUTHORIZATIONS**

ANS provides transportation of the activated components from the activation facility to the customer's site. This transportation is carried out (when necessary) by specialized companies chosen for their strict adherence to regulations pertaining to the handling of activated material. The activity produced on a component is always kept as low as possible. It is often possible to maintain it under the level for which legal authorizations are needed. When necessary, ANS provides full assistance to its customers for the administrative work required by legislation.

Because manipulations of activated components are of short periods, and the intensity decreases as a function of the distance to the source, the dose received from an activated component is typically very low. Intervening materials also contribute to the attenuation of the intensity. The manipulation and use of activated components usually necessitates only the most basic care.

The realization of a disposal program for used activated components and materials is part of every package offered by ANS. If necessary, ANS will take care of the removal of these items from the site of the application for disposal.

5. About ANS Technologies...

ANS Technologies *is a division of Atlantic Nuclear Services Ltd., a private company that provides a wide range of scientific products and services to industry and government.* ***ANS*** *is also involved in forefront technological research in cooperation with several universities, government and private concerns.* ***ANS Technologies*** *offers a range of services and products in the field of Thin Layer Activation.*

ANS*, through its own expertise, as well as many contacts within the nuclear, electronic, computer and aerospace industries, is committed to providing its clients with the very latest and best that is available in the field of non-destructive testing, of which Thin Layer Activation is an important part.*

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