

# INDUSTRIAL FLAW DETECTION AND NON-DESTRUCTIVE DIAGNOSTIC: A NEW APPROACH

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**J**SC NTI (Zelenograd, Moscow) is part of the NT-MDT Group, which has developed scanning probe microscopes for over twenty years and is a recognized leader on the Russian market of scanning probe microscopy (SPM) and known worldwide.

Up until recently, our instruments were mostly purchased by scientific laboratories and research centers working in different fields (chemistry, physics, biology, etc.) at major scientific and industrial centers in Europe, Asia, and North America.

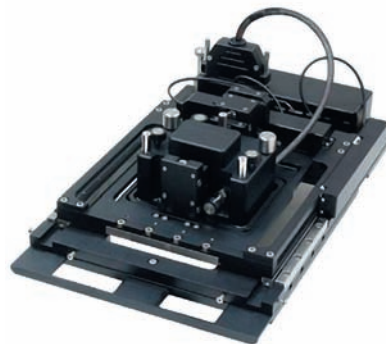
In 2010, we set the goal of creating an industrial instrument for the non-destructive testing and diagnostics of the structural materials of industrial equipment. This project was implemented through a private-public partnership established by Russian Government Decree #218 of April 9, 2010, "On Measures of Public Support for the Development of Cooperation

between Russian Higher Educational Institutions and Organizations Implementing Integrated Projects for Establishing High-Technology Production" and in the framework of Agreement #13.G25.31.0052 "On the Conditions for Allocating and Using Subsidies for Implementing an Integrated Project on Establishing High-Technology Production with the Participation of a Russian Higher Educational Institution."

The first prototype industrial scanning probe microscope was developed and presented under the provisional name SOLVER Pipe.

In comparison with the material testing methods used today (optical microscopy, X-ray radiography, electron microscopy, ultrasound flaw detection, etc.), atomic force microscopy (a variety of SPM) has a number of major advantages:

- Ultrahigh spatial resolution (down to nanometers);



**SOLVER Pipe prototype scanning probe microscope**



**Kirill Balizh**

- Compact instrument that requires no additional complicated vacuum or other specialized technology;

- Much greater zoom range than in optical microscopy for better material structure testing; AFM images of material structures at different zoom levels contain more useful information;

- AFM images are digitalized from the start and easy to process;

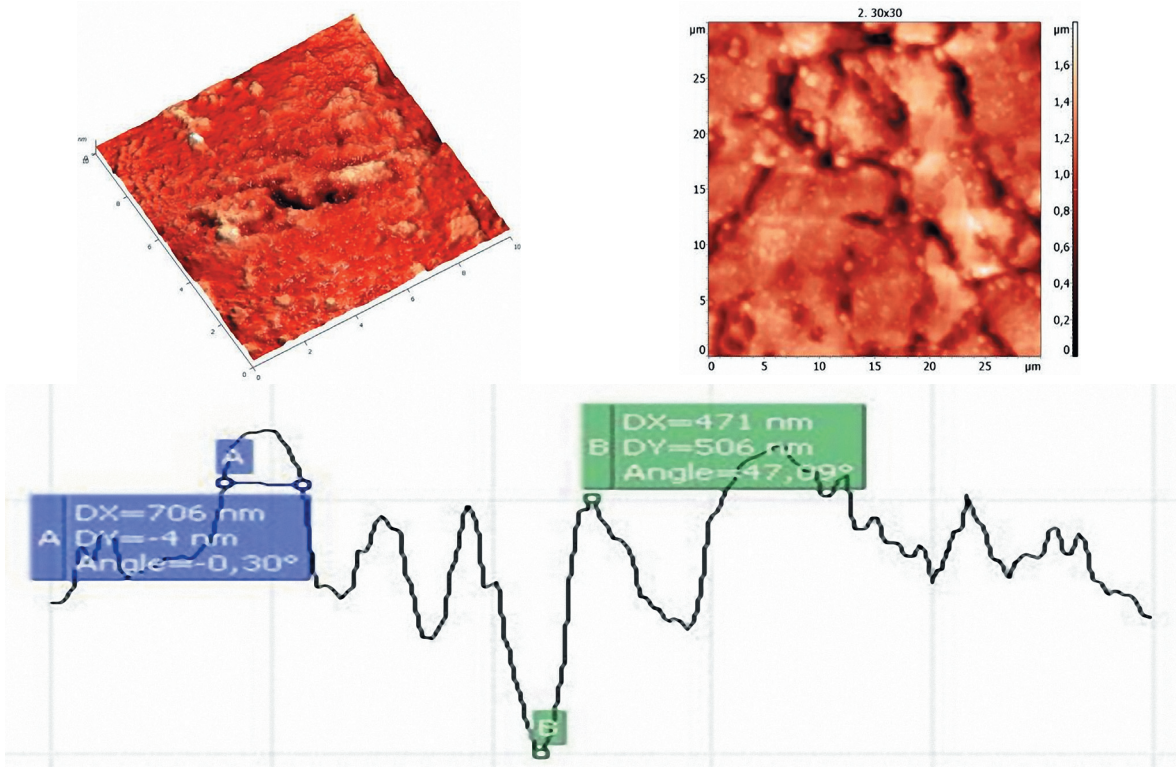
- AFM can simultaneous study the nanostructure and hardness of materials;

- High-speed results;

- Data are simple to interpret;

- AFM are superbly adapted to studying the structural and mechanical properties of materials.

SOLVER Pipe was specially developed for industrial diagnostics and can be mounted directly on the object to be tested. As a



*Two and three-dimensional AFM image of material flaw*

non-destructive testing instrument, the probe microscope can show changes in material structure when they are still only a few dozen nanometers in size (cracks, blowholes, and other types of flaws), i.e., when they have just appeared. One of the main aims of such tests is to assess the remaining life expectancy of equipment and ultimately attain accident-free operation.

SOLVER Pipe consists of a microscope on an automated platform that moves along the x, y, and z-axes. Belts are used to mount it on cylindrical (with a diameter ranging from 120 mm to several meters) and flat objects at any angle. The instrument's rotational mechanism allows the probe to be positioned at right angles to the sample. Thanks to the instrument's small size, it can also be used in the laboratory for studying large samples.

The instrument has a video camera that helps select the testing spot quickly and in a visual manner as well as to monitor the testing process. Its high zoom power makes it possible to compare the AFM results with ordinary optical images.

The digital AFM images are easy to process with the help of mathematical statistics and image recognition theory and can be pieced together, giving nanometer-scale images of comparable size to optical microscopy. AFM images are three-dimensional data arrays, making it possible to measure the size of objects along three axes.

The SOLVER Pipe scanning probe microscope is developed as a software-hardware complex for the study of large-scale industrial objects. The complex can be used for materials testing on industrial equipment such as pipeline sections, metal structures, turbine rotors, chemical reactors, high-pressure vessels, etc.

Far-away and hard-to-access industrial facilities can be equipped with SPM complexes for



*SPM mounted on a pipe*



*SPM mounted on a turbine*

the remote monitoring of materials of vital technological facilities without human interference.

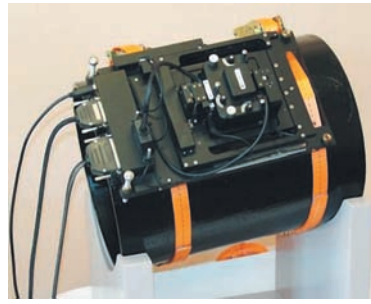
The SOLVER Pipe software-hardware complex can be used to solve the following tasks:

- Quality control of produced materials;
- Testing materials that were subject to extreme conditions for a long time;
- Testing parts and systems of functioning industrial equipment.

SOLVER Pipe can be used for making required tests and scheduled replacements of equipment to assure the virtually accident-free operation of enterprises in the following industries:

- Oil and gas;
- Chemical industry;
- Power;
- Metallurgy;
- Machine Building.

The SPM was first used for direct non-destructive testing of a pipeline in real (industrial)



**SPM**  
**mounted on a sample**

conditions at the oil refinery Raffineria di Roma (Italy).

The test showed that SPM is a modern and promising diagnostic tool for detecting flaws in metallic structures at industrial facilities and conducting quick and informative tests.

The equipment was tested for the second time at a plant for servicing steam turbines in Poland. This was the first time that the instrument was used to test such objects as a steam turbine rotor. One had to use test results to identify and study zones with material flaws. SPM

performed excellently once again and demonstrated its capacity to work on non-standard samples.

The interest evoked by the SOLVER Pipe SPM at numerous shows, conferences, and industrial meetings shows the demand for such instruments in industrial testing.

For example, JSC NTI participated in late 2010 in a show at the RUSNANOTECH 2010 III Nanotechnology International Forum.

The company presented an impressive stand presenting its latest developments in scanning probe microscopy and technological equipment for industrial applications. The SOLVER Pipe prototype was shown for the first time at such an event and evoked a lot of interest from the stand's visitors, including a Russian governmental delegation headed by Deputy Prime Minister Sergey Ivanov and RUSNANO CEO Anatoly Chubais. □

