



Scanning electron microscope supports development of next-generation ceramics



Morgan inspects advanced ceramic components used in applications ranging from cancer treatment to pump technology

A JCM-6000 NeoScope benchtop scanning electron microscope (SEM) from Nikon Metrology was recently deployed at Morgan Advanced Materials' Innovation Hub in the UK. It is a world-class facility combining technically advanced analytical equipment and development expertise to meet the technical challenges of the company's customers.

World-leading oncology support

A good example of the market-leading materials research being undertaken is the work on exciting new technologies such as ceramic injection moulding. Its complex forming capability has allowed Morgan to produce a commercially available, high precision ceramic tip for microwave ablation of tissues to remove tumors. Due to its micro design, patient trauma following surgery is significantly reduced.

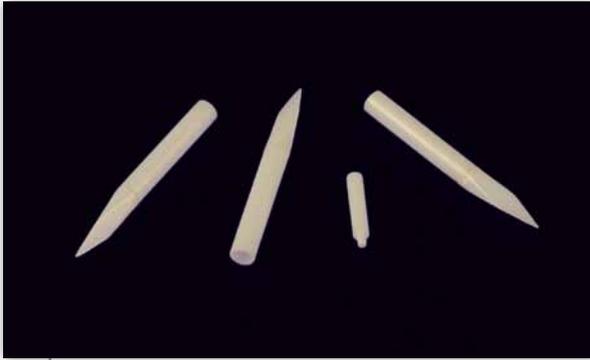
The extremely fine structure of the material imparts high strength and toughness, which are critical for the demanding application. Due to the material's small grain size, its microstructure cannot be analyzed using the company's standard 50x optical microscope, so SEM techniques were required.

Dr Tim Clipsham, Technical Manager, Morgan Advanced Materials, said, "The JCM-6000 was essential to enable our scientists to develop a material with advanced properties to suit this medical customer's specification.



Having the benchtop SEM from Nikon Metrology on-site also allows us greater control over the equipment and the outcome from the analyses.

Dr Tim Clipsham, Technical Manager, Morgan Advanced Materials



High precision ablation tips produced at Morgan Advanced Materials by ceramic injection moulding. The resulting fine-grained material cannot be optically inspected, which was one of the reasons for the company investing in the Nikon Metrology benchtop SEM.



The ceramic tips are used in microwave tissue ablation equipment for cancer treatment.

Previously, when our inspection requirements fell outside the capabilities of optical microscopy, we used to subcontract SEM analysis. In recent years, the need for such analysis has steadily increased, making it critical to our on-going business activities to install this facility in house.

Having the benchtop SEM from Nikon Metrology on-site also allows us greater control over the equipment and the outcome from the analyses. Our material scientists, with their high level of expertise in our materials, are able to optimize and focus the analysis to our requirements better than the microscopists working at subcontracting companies.

As a result, time can be saved with in-house SEM analysis, as previously preliminary analysis sometimes had to be carried out externally and then submitted to our technical team for advice before full in-depth analysis of the samples could be undertaken."

As a direct consequence, the technical support provided by Morgan's material scientists and engineers to production functions and customers has been optimized.

With the JCM-6000, sample preparation is minimal compared to that required for more traditional SEMs or even optical microscopes. One characteristic of the benchtop SEM from Nikon Metrology is that electrically resistant materials can be analyzed without applying a conductive coating to the surface, which is not the case with most

SEMs on the market. Therefore non-destructive tests on ceramic components can be performed quickly.

Moreover, the depth-of-field on an SEM is much greater than on most optical instruments, facilitating analysis on the surface and also on raised features or cavities of samples, allowing Morgan to gather a greater amount of information."

Development of friction materials for pumps

Morgan's Stourport facility is also a major supplier of high precision components which are supplied to market-leading pump manufacturers. A new friction material has recently been developed for hard-wearing pump seal applications in demanding industrial and petrochemical processing environments. The material has a composite structure, which enabled Morgan's materials scientists to tailor its friction performance for use in harsh field conditions.

The JCM-6000, with its energy dispersive spectrometry (EDS) capability, played a key role in the development of the material. It enabled the company to tailor its elemental composition and composite structure, using both the SEM's back scattered electron detector and elemental mapping feature.

Dr Clipsham continued, "Elemental mapping within a sample, analyzed in the SEM by measuring the energy and intensity distribution of X-ray signals generated by focusing an electron beam on the specimen surface, yields a wealth of information that



One use for the ceramic seals is in pumps for demanding industrial and petrochemical processing environments.

“

Our quality and production engineers are finding new uses for the equipment all the time and now that the microscope is in place, we would all find it very difficult to do without it.



Ceramic mechanical seals made from Morgan Advanced Materials' newly developed friction material.

was previously unavailable to us using optical inspection. Materials development and structure tailoring is much easier as a result.”

Other applications for the SEM

The JCM-6000 is currently playing an active role in both the development of new ceramic materials at the Innovation Hub and in on-going improvement projects. The instrument's user friendly software has enabled Morgan to extend the use of this analytical equipment to a broader range of its operations.

Dr Clipsham stated, “Our quality and production engineers are finding new uses for the equipment all the time and now that the microscope is in place, we would all find it very difficult to do without it.”

Moreover, due to the SEM's charge reduction mode and large chamber, oxide ceramic materials can be analyzed with less sample preparation compared to that required for research-level SEM systems, as there is no need to apply conductive coatings or to section the components to obtain essential information concerning components' surface features or chemical composition.

Purchasing decision

Dr Tim Clipsham advised that Morgan opted for a benchtop SEM because the equipment better suited its business needs due to the microscope's versatility and ease of operation. A research-level type SEM is considerably more restrictive as regards its installation and a specialist operator is needed. Of the four benchtop models shortlisted, the Nikon Metrology JCM-6000 was chosen due to its superior image quality and the availability of an EDS attachment for chemical analysis.

He concluded, “Such instruments can be used at ambient room temperature and are easy to operate. It took just a few hours to learn how to use all the functions of the JCM-6000.

The 60,000x magnification covers practically all of our applications. In the rare event that we need to go above that, we would subcontract the analysis – but the need has not arisen since the JCM-6000 was installed.”



Morgan Advanced Materials take ceramic fault diagnosis to the next level. Picture shows a defect on the surface of an alumina component on the screen of the Nikon Metrology JCM-6000 NeoScope.

About the Nikon Metrology SEM

As simple to use as a digital camera, the economically priced JCM-6000 NeoScope bridges the gap between optical microscopy and a research-level SEM. Developed by Tokyo-based JEOL (Japan Electron Optics Laboratory), it is a high-resolution instrument that has the ability to observe fine surface morphology at the sub-micron scale. Applications extend from bioscience, forensics and pharmaceuticals to a wide range of industrial uses, including failure analysis.

The SEM produces images with a large depth of field at magnifications ranging from 10x to 60,000x and offers high and low vacuum operation, three selectable accelerating voltages, secondary electron detection and back-scattered electron imaging. Focus, alignment, contrast and brightness adjustment are all automated.

The SEM accommodates samples up to 70 mm in diameter and 50 mm thick and examines both conductive and non-conductive samples without any special sample preparation. The EDS for elemental analysis is an option.

Another feature is its touchscreen interface, with the familiar look and feel of today's smart phones and tablets. Automatic functions as well as pre-stored menu files make it easy to study a variety of material types. From loading a sample to imaging in vacuum can be carried out in less than three minutes.

About Morgan Advanced Materials

Morgan Advanced Materials is a global materials engineering company which designs and manufactures a wide range of high specification products with extraordinary properties, across multiple sectors and locations.

From an extensive range of advanced materials, it produces components, assemblies and systems that deliver significantly enhanced performance for customers' products and processes.

Engineered solutions are produced to very high tolerances and many are designed for use in extreme environments. The company thrives on breakthrough innovation. Materials scientists and applications engineers work in close collaboration with customers to create outstanding, highly differentiated products that perform more efficiently, with greater reliability and for longer.

Morgan Advanced Materials has a global presence with more than 10,000 employees across 50 countries serving specialist markets in the energy, transport, healthcare, electronics, security and defence, petrochemical and industrial sectors. It is listed on the London Stock Exchange in the engineering sector (ticker MGAM).

For more information on Morgan Advanced Materials, visit: www.morganadvancedmaterials.com