UPGRADE OF TARGET CHAMBER AT THE END STATION OF SCANNING NUCLEAR MICROPROBE

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The article describes the modernization of the equipment of the chamber for interaction of a focused beam of MeV light ions with samples in the scanning nuclear microprobe end station of the analytical accelerator complex of the Institute of Applied Physics of the National Academy of Sciences of Ukraine. The sample holder was replaced, the video camera for focusing the beam on the quartz screen was replaced, and an additional video camera for positioning the samples and LED lighting for it were installed. The detector of characteristic X-rays for microanalysis was also updated. A new data acquisition system for local microanalysis using the µPIXE technique was put into operation.

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INTRODUCTION

The scanning nuclear microprobe end station at the IAP NAS of Ukraine was put into operation in 2006 [1]. Its characteristics and application until recently are discussed in [2]. During its operation, a number of shortcomings were identified that complicate the experiments. Earlier it was shown that the depth of focus in the microprobe end station is 200 µm. In the sample holder, the quartz screen used to focus the beam was not in the same plane as the surface of the samples, which led to a partial increase in the beam diameter on the samples and a decrease in resolution. The rear video camera used to focus the beam had insufficient resolution and inconvenient mechanics for adjusting and focusing on the quartz screen. In addition, there was no way to visually monitor the positioning of the samples, which made it impossible to detect a failure in the positioning system in a timely manner. The X-ray detector (XRD) had exhausted its lifetime and partially lost its resolution.

Based on the above, we are considering technical solutions to modernize the chamber equipment to eliminate these shortcomings.

1. SAMPLE HOLDER

The appearance of the old and new sample holders shown in Fig. 1.

Fig. 1. Exterior of the old (left) and new (right) sample holder in the target chamber

The quartz screen for focusing in both holders is fixed in the center hole. The old holder (left) shows that the surface of the samples is not in the same plane as the quartz screen. In contrast, in the new holder (right), both the samples and the quartz screen are fixed on the lower surface of the copper plate and are thus in the same plane. The new holder ensures that the beam is optimally focused on the surface of the samples.

2. VIDEO CAMERAS, DETECTOR AND DATA ACQUISITION SYSTEM

Fig. 2 shows the appearance of the target chamber with the updated video cameras. The frontal video camera in combination with an optical microscope (1) is intended to visually monitor the positioning of samples. It is mounted at a 45-degree angle and provides a view of the samples from the beam side. The magnification of the optical system is 100X. This video camera is equipped with LED backlighting (2), which is powered by the standard video camera source with the ability to adjust the brightness. The rear video camera (4) is also combined with an optical microscope and was installed to replace the old one to increase the spatial resolution. It is intended to observe the beam shape on the quartz screen during the adjustment of the probe-forming system and beam focusing. The magnification is 180X.

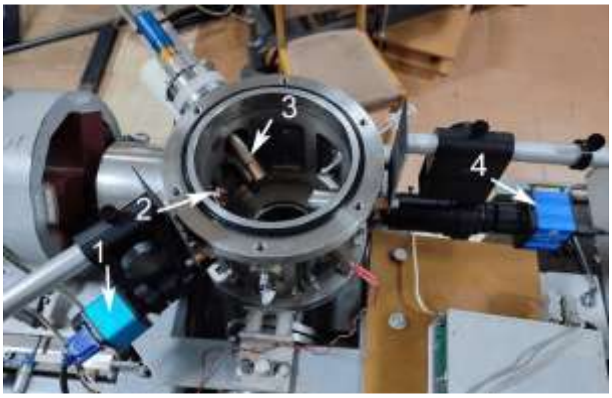

Fig. 2. Exterior view of the target chamber with the installed equipment. 1 – front video camera; 2 – LED backlight; 3 – XRD detector; 4 – rear video camera

Both cameras with optical systems are mounted on specialized optical microscopy holders that provide easy focusing.

A new Amptek XR100-CR (3) characteristic X-ray detector was installed to replace the old one of the same brand that had expired. It is planned to be operated with the DP5 signal processor module. The internal view of the interaction chamber is shown in Fig. 3.

A scanning control system of the ion beam of MeV energies has been developed for the scanning nuclear microprobe and proton-beam writing end station [3]. The system was put into operation to replace the obsolete one based on microcontrollers.

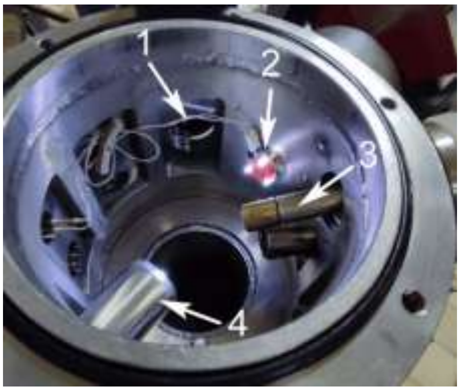

Fig. 3. Internal view of the camera with the installed equipment. 1 – location of the front video camera for positioning monitoring; 2 – LED backlight; 3 – CBR detector; 4 – location of the rear video camera for focusing

The scanning control system is based on a National Instruments reconfigurable module with a Field Programmable Gate Array NI 7852R. The module operates in real time and connected to a personal computer by a high-speed PCI-Express interface with data buffering. The system provides two main modes of operation: exposure of sample areas with a given profile and raster secondary electron imaging of the sample or a calibration grid. Profile exposure is possible in both raster and functional scanning modes. Automatic calibration of the profile scale and scan raster has also been implemented. The use of reconfigurable logic makes it possible to adjust the system quickly to the conditions of a particular experiment and the available equipment. The hardware capabilities of the scanning control system allows to connect up to 4 spectrometric ADCs for mapping the elemental composition of samples with different nuclear physics techniques. The Particle Induced X-ray Emission technique has now been implemented. Fig. 4 shows a screenshot of the data acquisition system in the element-mapping mode using the μPIXE technique, where the total PIXE spectrum and the location map of the selected element are visible.

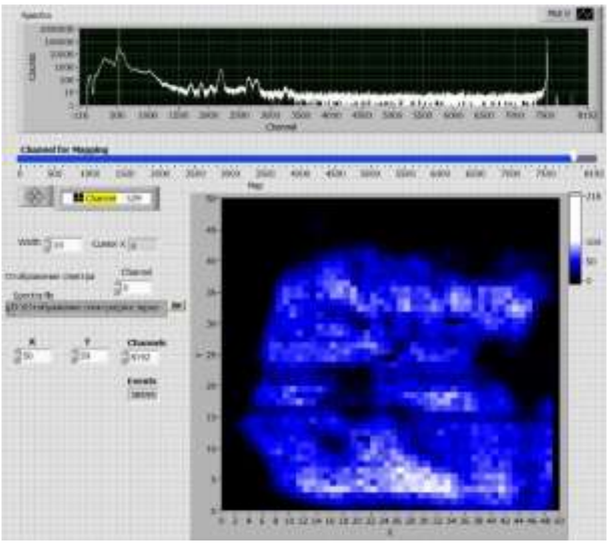

Fig. 4. Screenshot of the data acquisition system in the element-mapping mode using the μPIXE technique

CONCLUSIONS

The target chamber equipment was upgraded by replacing the sample holder, replacing the focusing video camera with a higher resolution 52 megapixel camera, and installing an additional video camera with LED lighting to simplify the positioning procedure. The X-ray detector and its electronics were replaced. A new data acquisition system for local microanalysis using the μPIXE technique was developed. Commissioning and parameter verification are planned for the near future.

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