

The Miniaturized Mössbauer Spectrometers MIMOS II & MIMOS IIA: Instrument Development and Applications

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The Miniaturized Mössbauer Spectrometer MIMOS II has been developed for extraterrestrial applications and has contributed significantly to the success of NASA's Mars Exploration Rover mission [1]. MIMOS II is part of the science payload onboard NASA's twin Mars Exploration Rovers "Spirit" and "Opportunity" (see Fig.1) . In January 2004, the first in situ extraterrestrial Mössbauer spectrum was received from the Martian surface.



Fig.1 : Artist view of the Mars Exploration Rovers. Size of the rover is about 1m x 1m (length and width) by ~1.6m high (position of the Panorama Camera).

The Mössbauer spectrometer is mounted on the robotic arm (IDD), together with a microscope (~30 micron resolution per pixel), the APXS for chemical analysis (XRF), and a grinder and drilling tool (RAT).

An improved version of the instrument was part of the scientific payload of the Russian Phobos-Soil mission in 2011 [3]. Because MIMOS II works in back-scattering geometry, no sample preparation is needed. In addition to 14.4 keV γ -rays, 6.4 keV X-rays can be detected simultaneously. The sampling depth of a photon is energy dependent, so that 6.4 keV X-rays are more sensitive to the surface part of a sample. In stainless steel, the sampling depth is on the order of ~50 μm . [2].

We have developed a new instrument MIMOS IIA with XRF capability for future missions to Mars, Venus, Martian moons, asteroids and the Earth moon. This instrument also has high potential for new terrestrial applications. MIMOS IIA uses newly designed Si-Drift detectors [4] with circular geometry (SDDs) allowing high resolution X-ray fluorescence spectroscopy simultaneously to Mössbauer measurements. The main goal of the new detector system design is to combine high energy resolution at high counting rates and large detector area while making maximum use of the area close to the collimator of the ^{57}Co Mössbauer source. The energy resolution at 5.9 keV is 136 eV FWHM at -20°C , increasing the signal to noise ratio (SNR) and reducing the integration time of a Mössbauer measurement by a factor of up to 10 compared with the MER instrument MIMOS II.

Due to its miniaturization and back scattering geometry **MIMOS II / MIMOS IIA** are portable and can be used in a wide range of Fe-Mössbauer applications, especially where no sample preparation is possible (**non-destructive measurement**). The system operates autonomously without any time limitations. **MIMOS II/IIA can also be used for transmission measurements** in standard lab applications.

References

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