

MÖSSBAUER SPECTROMETER FOR MINERALOGICAL ANALYSIS OF THE MARS SURFACE: MÖSSBAUER SOURCE CONSIDERATIONS

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Development of space rocketry and cosmic instrument making has made it possible to create interplanetary stations to be sent to the solar system bodies. In the last decade of the century the planet Mars will be in the focus of planetary science problems. Russia, USA (the NASA) and Europe (the ESA) plan to do a new step in the study of the planetary system by spacecraft missions to Mars. One part of the programs of these missions is Martian surface measurements of iron, which is a dominant element in both the Martian soil and rocks (about 13% by weight). The chemistry of iron in space is strongly coupled to the chemistry of abundant elements (to begin with hydrogen, carbon, oxygen) and it is this coupling of chemical cycles of abundant elements that gives us the possibility of understanding some features of the chemical evolution of matter [1]. In this connection of extremely great importance for the understanding of the evolution of the solar system are the oxidation state of the iron and its mineral composition of the Mars surface. Being highly successful, the Viking landers had no instrumentation to answer these questions. Such instrumentation has to be specifically sensitive to mineralogy. For these purpose the backscattering Mössbauer spectrometer (MS-96) was proposed to be installed on a rover to be launched on board the Russian spacecraft Mars-96 mission to Mars [2]. Due to power and mass restrictions three systems of the device MS-96 (velocity transducer, detector and electronic components) have been extremely miniaturized in comparison to a standard system. In this paper we intend to place for consideration a radioactive source to find out what characteristics it should have to be suitable for purposes of the experiment.

Our first task was to select a matrix with which the source on the Martian surface would yield high resolution spectra with maximized signal to noise ratio. We ought to conclude that (for activity loading up to about 2 Ci/cm^2) for assumed Martian conditions the Rh- matrix is the best matrix in any respect.

Our second task was to choose the source activity. On the one hand, an increase of the source activity allows performing the measurements in a shorter time because of the increasing count rate and the reduction of relative statistical errors. On the other hand, in order to increase the source activity without changing its dimensions it is necessary to increase the concentration of radioactive nuclei in a source matrix. As the concentration rises so the probability increases of the Mössbauer nuclei having as nearest neighbors similar atoms instead of those of the matrix element. The result is that electric field gradients are produced which cause quadrupole effects and hence line broadening. We have calculated the relative changes in a Lorentzian width Γ , and in a 14.4 keV Lorentzian emission line maximum I_{max} with time for a 6 microns thick Rh matrix initially containing $1 \text{ Ci}\times\text{cm}^{-2}$ and $5 \text{ Ci}\times\text{cm}^{-2}$. Our calculati-

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ons and comparison with the first measurements with MS-96 device made by Klingelhöfer et al. [3] shows that the activity loading of $1 \text{ Ci} \times \text{cm}^{-2}$ is the most suitable for the Mössbauer spectrometer to be sent to Mars because the use of a stronger source with the same area will diminish the resolution of the instrument. The source used for this measurements had a diameter of the active area equal to the 4 mm.

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References: [1] J.M.Knudsen, *Hyperfine Interactions* 47(1989) 3-31; [2] E.N.Evlanov, L.M.Mukhin, O.F.Prilutski, G.V.Smirnov, J.Juchniewicz, E.Kankeleit, G.Klingelhöfer, J.M.Knudsen, C.d'Uston, *Lunar and Planetary Science* 22(1991) 361; [3] G.Klingelhöfer, J.Foh, P.Held, H.Jäger, E.Kankeleit, R.Teucher. *Hyperfine Interactions* 71 (1992) 1449