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Sciences prospected from the results of ground tests for NIRS3: the Near Infrared Spectrometer on Hayabusa-2

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NIRS3: the Near Infrared Spectrometer is one of the candidate scientific instruments which will be equipped on Hayabusa-2 mission. It aims to observe near infrared spectroscopy at the wave length band of 1.8-3.2 micrometer to detect specific molecular absorption lines, including the absorption by hydrated minerals at 3 micrometer, on the target C-type asteroid. The major purpose of NIRS3 is to observe the absorption bands of hydrated minerals in the 3 micrometer band on the candidate target C-type asteroid 1999JU3, which has been reported in ground observations to have an absorption band of hydrated minerals at 0.7 micrometer. C-type asteroids are thought to be mother celestial bodies of carbonaceous chondrites (C-chondrites). C-chondrites have been classified into sub-groups by their composition, organization, and isotope ratio of oxygen. The spectra of C-type asteroids have also been classified into sub-types by their inclination and the existence of absorption bands detected in ground observations. However, the relationship between the sub-groups of C-chondrites and the sub-types of C-type asteroids has not been clarified due to the effects of solar radiation and space weathering. Therefore, we will directly observe the surface of a C-type asteroid without the terrestrial atmospheric absorption in the 3 micrometer band using NIRS3. Detecting younger terrain by global mapping of the asteroid and the ejecta of new crater by the Small Carry-on Impactor (SCI) will also provide the spectra of surface less affected by space weathering. To estimate the quantities of the hydrated minerals with accuracies of 1 to 2 wt%, we designed the NIRS3 system to have a signal-to-noise ratio (SNR) exceeding 50 at 2.6 micrometer for global mapping.

The critical design of NIRS3 started in August, 2011. We performed ground properties tests and environmental tests using the engineering model of NIRS3-S and NIRS3-AE including the newly developed InAs sensor and the shutter. Results of SNR property tests implied that the rapid increase of the dark current in the InAs sensor degrades the SNR when the integration time exceeds 200 microsecond at 193K. Therefore, we improved the SNR by (1) cooling the sensor to below 187K to reduce the dark current low sufficiently for 400 microsecond integration, (2) sampling three-times of 400 microsecond integration in one shutter-open period, and (3) spectral binning of two channels. The adjusted SNR remains above 50 at 2.6 micrometer during a sufficient period for global mapping. The later sensor property tests of flight model produced the better qualities for noise and linearity (Nakauchi et al., this meeting), which suggests the on-board SNR will provide enough performance. Thus, NIRS3 will shed light on the initial composition, aqueous alternation, thermal metamorphism, and space weathering on the surface of a C-type asteroid.

Keywords: Hayabusa-2, asteroid, 1999JU3, NIRS3, near infrared, spectrometer