UV Irradiation and Near Infrared Characterization of Laboratory Mars Soil Analog Samples

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The search for molecular biosignatures at the surface of Mars is complicated by an intense irradiation in the mid- and near-ultraviolet (UV) spectral range for several reasons: (i) many astrobiologically relevant molecules are electronically excited by efficient absorption of UV
radiation and rapidly undergo photochemical reactions; (ii) even though the penetration depth of UV radiation is limited, aeolian erosion continually exposes fresh material to radiation; and (iii) UV irradiation generates strong oxidants such as perchlorates that can penetrate deep into soils and cause subsurface oxidative degradation of organics. As a consequence, it is crucial to investigate the effects of UV radiation on organic molecules embedded in mineral matrices mimicking the martian soil, in order to validate hypotheses about the nature of the organic compounds detected so far at the surface of Mars by the NASA Mars Science Laboratory's (MSL) Curiosity rover, as well as organics that will be possibly found by the next rover missions Mars 2020 (NASA) and ExoMars 2022 (ESA-Roscosmos). In addition, studying the alteration of possible molecular biosignatures in the martian environment will help to redefine the molecular targets for life detection missions and devise suitable detection methods. Here we report the results of mid- and near-UV irradiation experiments of Mars soil analog samples obtained adsorbing relevant organic molecules on a clay mineral that is quite common on Mars, i.e. montmorillonite, doped with 1 wt% of magnesium perchlorate. Specifically, we chose to investigate the photostability of a plausible precursor of the chlorohydrocarbons detected on Mars by the Curiosity rover, namely phthalic acid, along with the biomarkers of extant life L-phenylalanine and L-glutamic acid, which are proteomic amino acids, and adenosine 5'-monophosphate, which is a nucleic acid component. We monitored the degradation of these

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molecules adsorbed on montmorillonite through in situ spectroscopic analysis, investigating the reflectance properties of the samples in the Near InfraRed (NIR) spectral region. Such spectroscopic characterization of molecular alteration products provides support for two upcoming robotic missions to Mars that will employ NIR spectroscopy to look for molecular biosignatures, through the instruments SuperCam on board Mars 2020, ISEM, Ma_Miss and MicrOmega on board ExoMars 2022.

Słowa kluczowe

molecular biosignatures, Mars, UV irradiation, infrared spectroscopy, life detection

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