MOLECULAR COMPOSITION OF A RECENT LUNAR METEORITE: NORTHWEST AFRICA 11474

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Introduction: Lunar meteorites provide information regarding the formation and evolution of the lunar surface. Examination of lunar meteorites contribute to our geochemical understanding of the lunar materials [1,2,3]. Lunar crust consists mostly of plagioclase feldspar, pyroxene, olivine and ilmenite while there is contribution, to a lesser extent, from potassium feldspar, oxide minerals, calcium phosphates, zircon, troilite or iron metal [4]. Northwest Africa 11474 (NWA 11474) was found in 2017, and it was subsequently classified as a Lunar Feldspathic breccia [5]. Initial analyses showed that it contains mainly olivine and pyroxene [5]. Fayalite, ferrosilite and wollastonite are identified in NWA 11474 as well [5]. To our knowledge, there is no spectral data available on this meteorite thus far. We acquired a slab of this meteorite from owner of the main mass and prepared a thin section at the Department of Geology Engineering of Istanbul University. Here, we present infared and Raman spectra of various phases and their diversity in NWA 11474.

Methods: We collected nano-scale Fourier Transform infrared (nano-FTIR) spectra of various phases present in NWA 11474 at Institute of Accelerator Technologies, Ankara University, using commercial microscopy system (Neaspec GmbH, Germany), which provides ~20 nm spatial resolution. Subsequently, the same sample was investigated using a micro-Raman microspectroscopy setup at Science And Technology Application and Research Center, Canakkale Onsekiz Mart University. Here, experimental setup consist of a commercial WiTec alpha300 R (WiTec GmbH) confocal microscopic imaging system, a 532-nm Nd:YAG laser, a spectrometer and a 50X objective. High spatial resolution chemical distribution maps (0.5 µm) of NWA 11474 were collected using a laser power of ~1-3 mW and integration time of 0.2 seconds.

Results: Micro-Raman spectra show that NWA 11474 contains abundant pyroxene, evident from the Raman bands observed near 1015 cm^{-1} and 675 cm^{-1}. The latter band is a singlet in some cases, and a doublet in others, indicating presence of different endmembers. A set of additional pyroxene bands appear between 443-302 cm^{-1}, which is a singlet, doublet, or triplet in different spectra collected from different points. This is indicative of a varying molecular composition depending on the endmember. A doublet centered near 840 cm^{-1} is due to olivine and is observed in the spectra of some of the phases. Although olivine is present in NWA 11474, its abundance is significantly less than that of pyroxene. We also observed a currently unidentified phase whose Raman bands appear around 495 cm^{-1} and 515 cm^{-1}. Using Raman positions of the observed bands, we generated chemical distribution maps of the phases to qualitatively investigate their spatial distributions and relations. Nano-FTIR spectra of NWA 11474 show silicate bands between 800-1200 cm^{-1} that are due to Si-O stretching vibrations, although variations in the peak positions exist and are indicative of difference in the molecular composition of the silicates. Some spectra present infrared peaks between 880-1080 cm^{-1}, while others present between 920-1240 cm^{-1}. Overall, our preliminary investigation shows that NWA 11474 contains various minerals with different chemical composition, and we are able to identify different endmembers through infrared and Raman spectroscopy. We have plans to do more detailed investigations to better understand its mineralogy.

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