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Charged nanosilicate Clusters and their Interaction with Oxygen: Astronomical Relevance

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Silicates are ubiquitously found as small dust grains in the interstellar medium, where they are processed due to high-energy processes, such as UV radiation absorption. These abundant nanosilicates are likely to play an important role in astrochemistry. In this work, we form small magnesium silicate clusters via laser vaporization of a binary Mg2Si target in the presence of diluted molecular oxygen. The formed species are characterized via a combination of infrared multiple-photon dissociation spectroscopy (IR-MPD) and DFT calculations. Analysis of the spectra of MgSiO9+ and Mg2SiO9+ reveal the preferred formation of a pyroxene monomer MgSiO3+ decorated with two non-activated oxygen molecules. The remaining oxygen atoms bind to Mg2SiO9+ as a superoxide-like species, but they form an ozone-like O3 unit on MgSiO9+. Due to the potentially high abundance of pyroxene monomers in the diffuse interstellar space, these findings could have important implications for the role of small silicates in explaining the missing oxygen in the diffuse ISM. Furthermore, in the Mg2SiO9+ cluster the second Mg atom is found to bind to the MgSiO3 monomer core, which can be considered as the simplest initial step in silicate grain growth and thus indicates that small ionized pyroxenic clusters could assist in the initial stages of silicate dust re-birth in the ISM.

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