Unveiling dark objects in Solar System: grain size effects on the infrared spectrum of mineral mixtures in presence of opaque components

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Dark surfaces characterize several bodies in the Solar System: from primitive carbonaceous asteroids to the enigmatic surface of Phobos and Deimos, our knowledge on the spectroscopic behaviour of low albedo surfaces is still incomplete. A dark surface can be related to multiple factors, for example presence of opaque material [1] or strong surface alteration [2]. In order to interpret remote sensing data, laboratory studies remain a pivotal tool to unveil the surface physical state and composition.

Several processes can be simulated in the laboratory, but the preparation and analysis of complex mixing of analog material is one of the most fundamental tool and, at the same time, one of the most complex study when multiple components are used. In this work, we aim to study how dark material mixed with basaltic material at different grain sizes can affect the spectroscopic features from near- to mid-infrared (1.25-25 µm).

Our sample set includes four series of basaltic mix (feldspar and pyroxene), at different grain sizes from < 50 µm to 1000 µm, mixed with amorphous carbon at increasing weight percentages from 1% to 50%. We analysed several features on the spectrum of each mineral mixture: (i) near infrared slope; (ii) 2.7 µm OH-stretching band; (iii) Christiansen features; (iv) Reststrahlen band and Transparency feature. Measurements presented in this work [3], for the first time take into account a large wavelength range and point towards a critical effect of dark material with a different outcome for each grain size. Some of the most interesting results involved the slope and the different behaviour of the Reststrahlen band. This dataset will be a good support in the interpretation of upcoming data from Phobos Martian Moon eXploration mission, as well as in understanding of previous data from dark surfaces in the Solar System like Ryugu and Bennu.

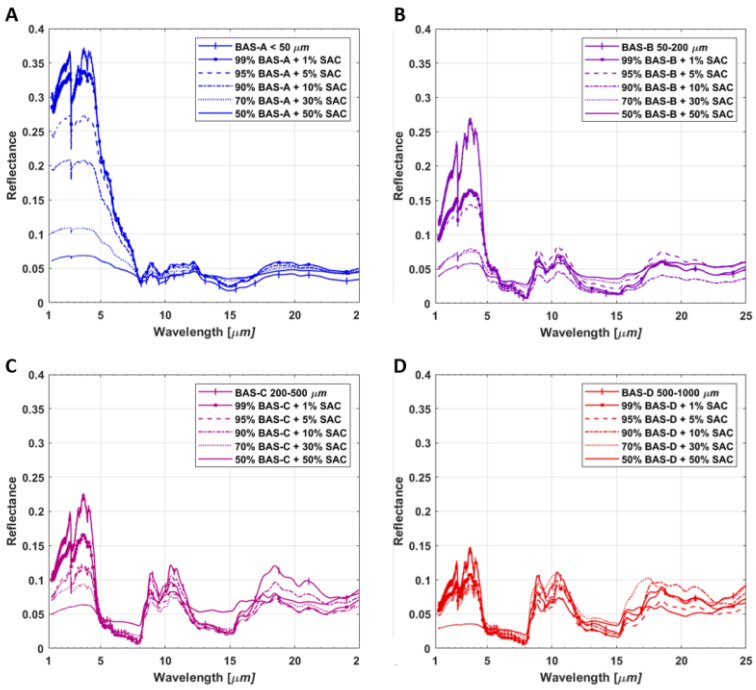

Figure 1. Infrared spectra of basaltic mixtures [BAS] at different grain sizes, <50, 50-200, 200-500 and 500-1000 µm, with addition in different proportions, from 1 to 50%, with synthetic amorphous carbon [SAC].

References

[1] Cloutis et al 1990, Icarus, 84 (2), 315-333 [2] Hasegawa et al 2022, The Astrophysical Journal Lettes, 939, L9 [3] Poggiali et al 2023, Astronomy & Astrophysics (submitted)