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ANALISYS OF THE ELECTROMAGNETIC BEHAVIOR OF LUNAR SOIL FOR FUTURE MOBILE TELECOMMUNICATION SYSTEMS IN THE 1-6 GHZ FREQUENCY BAND

Abstract

In recent years, the colonization of the Moon has increasingly become a topic of discussion because of the many scientific and technological issues that such a challenge demand. An open question is to understand how suitable the Lunar electromagnetic environment can be as example to reuse the current terrestrial mobile TLC systems, or whether it's necessary to provide new Mobile TLC systems specifically designed for the Moon. Indeed, the electromagnetic fields in mobile telecommunication systems are subject to absorption and scattering from all the materials on the planet surface as well as by all man-made objects. The lunar surface is mainly composed of rocks like terrestrial ones, and it is covered with regolith, a mixture of dust and rocky debris, whose chemical composition, thickness and electromagnetic absorption and reflectivity vary from one region to another. This experimental study considers electromagnetic measures on various types of lunar soil composition reproduced by analyzing literature available data. The base material used is dark pyroclastic sand, enriched by various percentages of silicates, iron and titanium oxides to make it more like the lunar seas' regolith. The Electromagnetic experimental characterization is performed using a reverberation chamber (RC), since its intrinsic capability to perform electromagnetic compatibility (EMC) tests and other electromagnetic investigations. The knowledge of the absorbed power allows to recover the absorption cross section (ACS) of the materials under test. The facility adopted to measure the ACS of the Lunar soil is the "Space Environment Simulator" of the Aerospace Systems Laboratory of DIAEE, Sapienza University of Rome, which is a cylindrical vacuum chamber with a volume

of 5m3. All the measures are performed in a medium-vacuum environment in the order of 10-3 mbar. The fundamental mode's resonant frequency is f0 = 200 MHz, giving a lower usable frequency (LUF) of about 5f0 = 1000 MHz. Two transmitting and receiving horn antennas are used for characterization in the range 1 - 6 GHz. A vector network analyzer is connected to the system to measure the transmission coefficient between antennas in the presence and absence of the sample in the chamber. Inside the chamber a vertical stirrer is placed: it is a Z-folded aluminum blade, moved gradually by a stepping motor, which ensures a resolution of 0.5 degrees, used to excite the absorbent material in a completely random way. The power of the RC is statistically evaluated through a set averaged over the rotation of the stirrer.