Abstract

of the doctoral thesis ″Characterization of physicochemical and technological properties of regolith simulants″

Efforts to colonise the nearest celestial body to Earth – the Moon – necessitate creating habitats and research infrastructure on its surface. Logistically, it is unfeasible to transport construction materials from Earth, so the only practical solution is to build infrastructure using locally sourced and processed materials. However, lunar regolith covering the Moon's surface is largely inaccessible for research because of its limited availability on Earth and high cost. Consequently, developing affordable, readily available, and high-volume lunar regolith simulants has become essential. These simulants will enable advanced, large-scale scientific research focused on developing technologies to process regolith into useful structural components suitable for the lunar environment. Applying this technology in real-world conditions, that is, on the Moon's surface, will facilitate easy, rapid, and cost-effective infrastructure construction.

Among the many materials potentially useful for producing regolith simulants, ash from Polish coal-fired power plants was chosen. This is an original approach, not documented in international literature (except for the limited use of ash as additives to basalt-based simulants). Ashes derived from current production and thermally treated ash underwent a series of tests, including analysis of their phase composition, chemical makeup, morphology, thermal and biological properties, and resistance to ionising radiation, which has a significant impact on the lunar surface.

The test results confirmed that the selected ashes, especially those thermally treated, show a high morphological similarity in phase composition to samples of original lunar regolith obtained during manned and unmanned lunar missions. Additionally, space bricks made from these prepared materials display thermal properties typical of ceramics, are non-toxic to human cells, and have satisfactory protective properties against ionising radiation.

The research led to the development of the composition and fundamental technological assumptions for creating a proprietary lunar regolith simulant, known as the **Upper Silesian Regolith Simulant**. Its phase composition and morphological properties classify it as a regolith simulant, comparable to regolith from the lunar highlands.