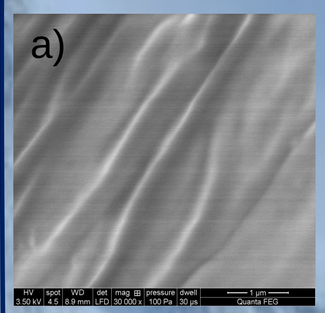
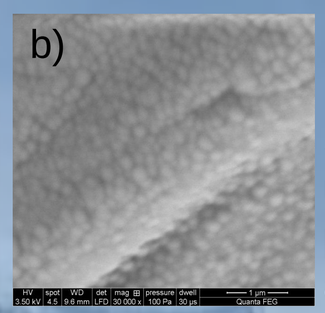
METHOD FOR PRODUCING DURABLE WATER-REPELLENT LAYER ON THE SURFACE OF NATURAL DOWN

DESCRIPTION OF THE INVENTION

The subject of the invention is a method of producing, by means of low-pressure and non-equilibrium plasma (cold plasma), a durable superhydrophobic nanostructure on the surface of natural down used as thermal insulating filler material for specialist and tourist clothes and equipment. A two-stage plasma process is used to form a hierarchical globular structure analogous to that observed on lotus leaves, providing the required superhydrophobic properties. In the first stage of the process, the surface of natural down is plasma activated to create growth centers. In the second stage, the down is covered with a very thin layer of plasma polymer produced by glow discharge from a silicon precursor. Using the active centers generated in the first stage, the plasma polymerization process leads to the growth of the layer chemically bonded with the surface of down, which guarantees its durability.
Examples of plasma reactors used in the described process are presented in the pictures.

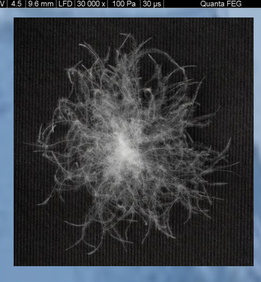
CHARACTERIZATION

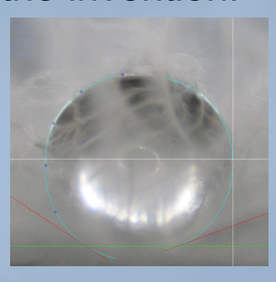


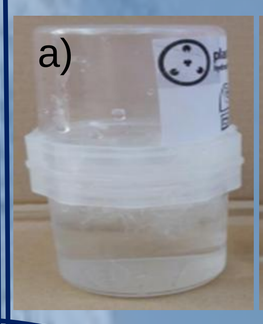


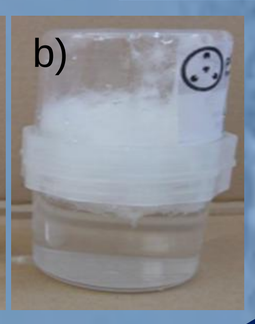
Surface morphology of unmodified (a) and cold plasma modified (b) down according to the invention.

Contact angle measurements performed on goose down. As good as 162°.



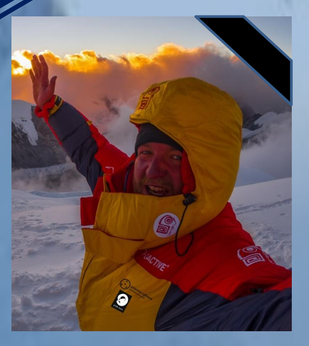






Natural goose down unmodified (a) and covered by superhydrophobic thin layer according to invention (b) after a shaking test in water.

APPLICATIONS



The first tests of non-wettable down were carried out by Olek Ostrowski in the high-mountain suit during the expedition to Cho Oyu in 2014.
The last tests were performed during the Polish National Winter Expedition on K2 2017/18. The peak attack suits and sleeping bags were made using plasma modified down.

THE NATIONAL WINTER EXPEDITION 2017/18

The superhydrophobic down can be used to fill not only specialized outdoor equipment, but also everyday clothing or bedding products, which are used in conditions of high humidity.

INNOVATIONS

polish down

The superhydrophobic down produced according to the invention is protected by trademarks presented on the poster and a patent PL 228924 B1. Compared to the competitors, it provides significantly higher hydrophobicity and durability of the applied layer. In addition, superhydrophobic down is characterized by unchanged functional parameters such, as thermal insulation, color, filling power or expansion. Besides, it is characterized by improved elasticity, which is maintained even with long contact with water. It absorbs much less water in its volume and after wetting it dries much faster.

The plasma technique is also characterized by significant advantages compared to conventional methods. First of all, it uses less chemical reagents in the production process, for this reason, it is considered to be environmentally clean and cost-effective method. In addition, the silicon precursors used in this technology are not toxic, and superhydrophobic layers made of them can be used in products for contact with human skin, in contrast to other compounds, for example, fluorocarbons.

plasma sphere
hydrophobic down

INVENTORS

Jacek Tyczkowski[1] – jacek.tyczkowski@p.lodz.pl
Ryszard Kapica[1] – ryszard.kapica@p.lodz.pl
Justyna Markiewicz[1]; Adam Małachowski[2]; Bartosz Małachowski[2]
[1]Department of Molecular Engineering, Faculty of Process and Environmental Engineering, Lodz University of Technology, Wolczanska 213, 90-924 Lodz, Poland
[2]PSA Malachowski s.c., Skoczowska 49, 43-426 Debowiec, Poland

INKUBATOR INNOWACYJNOŚCI +