1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title: Exotic carbon nanomaterials in new anti-icing surfaces

1.1. **Project goals** The main goals of this project are: creating new anti-icing surfaces, testing their hydrophobic and mechanical properties, and finally testing their anti-icing properties. The use of exotic carbon nanomaterials and new polymers will lead to the production of new anti-icing and self-healing materials with high hydrophobicity, lowering the nucleation temperature and delaying the formation of ice, including its Wenzel forms. The new materials will bring us closer to the critical adhesion force value of 12 kPa - the value below which ice is removed by wind, its own weight or vibration**.**

1.2. **Outline** The problem of icing occurs in everyday life in vehicles, airplanes, high voltage tractions, etc. The main ways to prevent icing (without heating) are: creating a surface with low droplet adhesion, suppressing ice nucleation and delaying the nucleation time. The project will allow the preparation of modern anti-icing surfaces through the use of modern material engineering techniques (including electrospinning, maskless photolithography) and surface embedding**.**

1.3. **Work plan** 1) Using the so-called the concept of Euler stability and monostable Cassie states, parameters characterizing new surfaces will be calculated. 2) Preparation of new surfaces using the methods mentioned above. 3) Research on the icing process in a special chamber equipped with a gyonometric system and an infrared thermometer. Ice adhesion strength testing using the CAT method. 4) Mechanical properties testing using a texture analyzer. 5) Estimation of the relationship between anti-icing and mechanical properties

1.4. **Literature** *(max. 10 listed, as a suggestion for a PhD candidate)* Y. Li, D. Quéré, C. Lv, Q. Zheng, Proc Natl Acad Sci USA 114 (2017) 3387–3392, 2) E. Korczeniewski, P. Bryk, S. Koter, P. Kowalczyk, W. Kujawski, J. Kujawa, A.P. Terzyk, ACS Appl. Mater. Interfaces 13 (2021)

37893–37903, 3) Y. Yu, Z.-H. Zhao, Q.-S. Zheng, Langmuir 23 (2007) 8212–8216, 4) S. Rønneberg, Y. Zhuo, C. Laforte, J. He, Z. Zhang, Coatings 9 (2019) 678., 5) Z. He, S. Xiao, H. Gao, J. He, Z. Zhang, Soft Matter 13 (2017) 6562–6568., 6) Y. Zhuo, V. Håkonsen, Z. He, S. Xiao, J. He, Z. Zhang, ACS Appl. Mater. Interfaces 10 (2018) 11972–11978, 7) T. Chang, F. Panhwar, G. Zhao, Adv. Mater. Interfaces 7 (2020) 1901959, 8) S. Wang, M.W. Urban, Nat Rev Mater 5 (2020) 562–583, 9) P. Bolibok, S. Koter, A. Kaczmarek - Kędziera, P. Kowalczyk, B. Łukomska, O. Łukomska, S. Boncel, M. Wiśniewski, K. Kaneko, A.P. Terzyk, Carbon 183 (2021) 948–957, 10) J. Kujawa, M. Zięba, W. Zięba, S. Al-Gharabli, W. Kujawski, A.P. Terzyk, Desalination 511 (2021), 115117

1.5. **Required initial knowledge and skills of the PhD candidate** willingness to work, use of the Office suite, basic knowledge of nanocarbon chemistry

1.6. **Expected development of the PhD candidate's knowledge and skills** will acquire skills in obtaining and characterizing surfaces, will acquire skills in operating an electrospinning device, maskless photolithography, and CAT adhesion analyzer