NewTimes – New Trends in Materials Science and Engineering
1st International Virtual Conference
14-18 June 2021

SESSION: *New trends in nanotechnology, nanostructures and nanoscience*
Preference: ORAL presentation

Hierarchical fibres to tailor the fibre/matrix interface in composite materials

J. Tirillò[1]*, F. Sarasini[1], M. Lilli[1], F. Sbardella[1], V. Cech[2], C. Scheffler[3], B. L. Wardle[4]

[1] Department of Chemical Engineering Materials Environment, Sapienza-Università di Roma & UdR INSTM, Via Eudossiana 18, 00184 Roma, Italy
[2] Institute of Materials Chemistry, Faculty of Chemistry, Brno University of Technology, Purkynova 118, 61200 Brno, Czech Republic
[3] Leibniz-Institut für Polymerforschung Dresden e.V., Group Reinforcing Fibres and Interphase Characterisation, Hohe Straße 6, 01069 Dresden, Germany
[4] Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA, 02139, USA

Over the past decades, the widespread use of glass fibres within polymeric matrix composite materials has significantly increased, leading to a strong interest in greater eco-sustainability due to the limited possibilities of disposal of these materials at the end of their life. For this reason, the production of bio-composite materials, using sustainable matrices or natural reinforcing fibres, has recently been a cornerstone of many research fields. Basalt fibres, due to their volcanic rock-based origin, are considered natural fibres and a green alternative to glass fibres. The challenge for the development of these new composite materials is the optimization of the load transfer between the fibres and the matrix, through an adequate interface. In this research project, in order to tailor the interface with polymeric matrices, unsized basalt fibres were surface modified through three different methods: low-temperature plasma process (PECVD) for surface deposition of tetravinylsilane ($Si(–CH=CH_2)_4$) or a mixture formed by tetravinylsilane (TVS) and different percentages of oxygen (0-0.71 oxygen fraction), low-temperature hydrothermal growth process of ZnO-nanorods and carbon nanostructures growth via low temperature chemical vapor deposition (CVD). After all these different processes, the basalt substrates were subjected to morphological analyses using scanning electron microscope (SEM), transmission electron microscope (TEM) or atomic force microscope (AFM), in order to characterize the nanostructures and the polymer plasma coating. In parallel, single fibre tensile tests have shown the influence of process conditions on the mechanical properties of the fibres, highlighting decreases up to 40 % in the case of the CVD technique, or even increases in the case of PECVD. Finally, the interfacial properties were investigated through single fibre pull-out tests and studies on surface energy with dynamic contact angle tests. The results showed an increase in interfacial shear strength (IFSS) in a range that goes from 16 % for fibres modified with ZnO nanorods, up to 80 % for fibres subjected to plasma polymerization.

Corresponding Author e-mail: jacopo.tirillo@uniroma1.it
*lead presenter: e-mail: jacopo.tirillo@uniroma1.it