Silica aerogel composites reinforced with reclaimed fibres obtained from textile industry wastes

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Silica aerogels exhibit extreme porosity, which grants outstanding insulation performance, both thermal and acoustic, even with reduced thickness [1]. However, their processing and handling is difficult due to their fragility. On the other hand, in an era of environmental awareness, Textile Industry is known by its sustainability deficit, with fashion sector ruled by shorten cycles. In fact, nowadays, there are new clothing trends coming out every week. Thus, the consumption of fibres is exponentially growing, along with the production of wastes. In a clothing manufacturing facility, wasted fabric typically ranges between 10 and 20% [2].
Fibres are excellent supporting webs to strengthen silica aerogels [3], being the textile fibre wastes a perfect raw material for this purpose. Cotton, the most used natural fibre in textiles, was used in this work as reinforcement of the silica aerogel matrix. Aiming to promote a circular economy, these reclaimed fibres were obtained from textile-wasted materials by mechanical processes. The aerogel synthesis methodology followed environment-friendly protocols and aimed as well to minimize the aerogel cost. TEOS was the main precursor (less expensive silane), and ethanol and ethyl acetate were the selected solvents for the synthesis and washing steps. Ambient pressure drying was applied for easy scale-up.
Despite the high thermal conductivity of cotton fibres in the longitudinal way (*ca.* 2 W m^{-1} K^{-1} [4]), silica aerogel composites with 34 mW m^{-1} K^{-1} (Hot Disk®) were developed. The optimal fraction of fibres was ~9 wt% of the dried gel. It was also found that longer fibres (average length of 12.4 *vs*. 9.4 mm) provided composites with higher insulation performance.

Acknowledgments. Teresa Linhares gratefully acknowledges Fundação para a Ciência e Tecnologia for the Doctoral Grant SFRH/BD/131819/2017. This work was also supported by the European Regional Development Fund (ERDF), through COMPETE 2020 Operational Programme for Competitiveness and Internationalization, combined with Portuguese National Funds, through FCT, I.P. [UIDB/EQU/00102/2020, UID/CTM/00264/2020].

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