

Acceleration of methane production by carbon nanotubes

Andreia F. Salvador¹, Gilberto Martins¹, Manuel Melle-Franco², Ricardo Serpa¹, Alfons J. M. Stams^{1,3}, Ana J. Cavaleiro¹, M. Alcina Pereira¹, L. Pereira¹, Olívia S.G.P. Soares⁴, P.S.F. Ramalho⁴, Manuel F. R. Pereira⁴, M. Madalena Alves¹

¹CEB - Centre of Biological Engineering, Universidade do Minho, 4710-057 Braga, Portugal
Group: BRIDGE | Line: Environmental Biotechnology and Bioengineering

²CICECO - Aveiro Institute of Materials, University of Aveiro, 3810-193, Aveiro, Portugal

³Laboratory of Microbiology, Wageningen University, Wageningen, The Netherlands.

⁴Laboratório de Catálise e Materiais (LCM), Laboratório Associado LSRE-LCM, Faculdade de Engenharia, Universidade do Porto, Portugal

Carbon nanotubes and other conductive materials have been found to influence the rates of several anaerobic reactions.

A range of different conductive carbon materials (CM) were reported to enhance methane production by anaerobic microbial communities. In most studies, the improvement of the overall process is attributed to the ability of these compounds to promote direct interspecies electron transfer (DIET) between bacteria, degrading more complex substrates, and methanogens, producing methane. The occurrence of DIET in the majority of these systems is not, however, proved and the effect of such conductive compounds on the activity of individual members, inside complex microbial communities, was never investigated. Thus, we herein present the results obtained when incubating pure cultures of methanogens, without any other microbial partner, in the presence of increasing concentrations of carbon nanotubes (CNT). Methane production from acetate, by the acetoclastic methanogens *Methanosaeta concilii* and *Methanosarcina mazei*, and from hydrogen plus carbon dioxide, by the hydrogenotrophic methanogens *Methanospirillum hungatei* and *Methanobacterium formicicum*, was accelerated, up to 17 times, in the presence of CNT [1]. Physical/chemical properties of the growth media changed in the presence of CNT, with redox potential decreasing with increasing CNT concentrations, and thus favouring methanogenesis. These findings show that CNT influences the microbial activity of methanogens in pure cultures and most likely this effect is extended to methanogens in complex communities as well, occurring in anaerobic bioreactors and in the environment.

Conductive materials also participate in biodegradation of recalcitrant compounds by acting as electron shuttles (ES), accelerating the process. Little amounts of different CM, namely activated carbon, carbon xerogels and CNT, act as ES in biotic and abiotic anaerobic degradation of azo dyes and aromatic amines, hasten considerably the reduction rates. CM associated with magnetic nanoparticles combine catalytic and magnetic properties. For example, CNT impregnated with 2% of iron (CNT@2%Fe), improved the rates of azo dyes reduction up to 79-fold and could be recycled as catalysts in successive decolourisation cycles [2].

In conclusion, addition of conductive materials is beneficial for accelerating biological and methane yielding biotransformations, improving the efficiency of environmental clean-up bioprocesses and bioenergy production.

References

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