Title: Additives for enhanced recycling of polyolefins and polycondensates

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Keywords: Energy conservation, emission reduction, recycling, advanced manufacturing.

Introduction: Polymer materials find use in an immense number of applications used in our daily life. One problem with the usage of plastics is that they are generally not biodegradable and might accumulate in nature if not disposed of correctly. In this project we address the challenges in recyclability of polyolefin and polycondensate polymers through the development of new additives that enhance the recyclability. These additives undergo self-assembly in the polymer matrix and thereby introduce various beneficial and unexpected properties to the blends; the additives act as compatibilizer, they acts as nucleating agent, and most importantly, they ease the processing through a viscosity reduction. This unique combination of properties makes these novel additives excellent candidates to improve the recycling process while simultaneously introducing new functionalities in recycled products.

Hypothesis and Objectives: Recently we have reported a series of nucleating agents for a wide range of materials including polypropylene, poly(lactic acid) and poly(hydroxyalkanoates)s. These additives can be introduced into the polymer melt via conventional processing methods such as extrusion and injection molding steps. On cooling the additives self-assemble prior to the crystallization of polymer matrix, and effectively suppress the nucleation barrier for crystallization of the polymer. Furthermore, these monomers can be efficient surface modifiers and also have been proven to lower the viscosity during the processing steps. Our ongoing study explores molecular understanding on the self-assembling aspects of a range of hydrogen bonded additives, with goal on optimization of their molecular design, for enhancing their efficiency in the chosen polymer matrix. Furthermore, the tendency of the additives to lower the viscosity of the polymer matrix, without lowering the molecular weight of the individual components is strongly desired when addressing the recycled products. The purpose of this study is to optimize the additive compositions, study their self-assembling behavior in various polymer melts, and via this route, improve the recyclability of both polyolefins and additive materials. The conventional processing routes such as extrusion, compression molding and injection molding will be employed. Additionally given the novel nature of the self-assembling additives, advanced manufacturing via 3D printing will be also explored.

Setting: The work will be performed within the Aachen-Maastricht Institute for Biobased Materials (AMIBM) and the Biobased Materials department of Maastricht University, both located at the Brightlands Chemelot Campus (Geleen), in the surroundings of industrial corporate R&D. Chemical development and study of the self-assembling additives will be performed using standard chemical tools such as NMR spectroscopy and gel-permeation chromatography. The compounding of small scale blends having various amounts of additives will be done in a small scale 4 ml mini-extruder, allowing us to perform detailed rheometry experiments, crystallization studies. Structure development during flow will be followed using a multi-pass rheometer having diamond windows that allows time resolved small angle and wide angle x-ray diffraction studies.

Requirements of the candidate: The candidate should be a passionate researcher with a background in chemistry and in particular in polymer materials. Furthermore, given the broad scope of this work, affinity with polymer physics and technology is desired.

Selected five publications of the supervisor: https://scholar.google.co.uk/citations?user=b79ixaoAAAAJ

1. **Nature Materials** 2005, *4*, pp 635−641. DOI:10.1038/nmat1437 (citations 192)
2. **Nature** 1991, 353 (6339), 55-57 (citation 66); **Nature (news & views)** 2000, 404 , 134-135 (citations 93)
3. **Physics Review Letters** 2008, 100 (4), 048302-48305 (citations 122)
4. **Carbon** 2006, 44 (4), 778-785 (citations 306)
5. **Industrial & Engineering Chemistry Research**, 2016, 55 (45), 11756-11766