Fast processing of epoxide polymers and composites by Radical Induced Frontal Polymerisation

Project type: Master thesis

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Frontal polymerisation has recently emerged as a promising alternative for processing of epoxide polymers and epoxide-based fibre reinforced composites, requiring only a fraction of the time and energy input compared to conventional thermal polymerisation (e.g. oven curing)[1]. The mechanism is based on an autocatalytic mechanism that can, after the application of an initial external trigger, form a self-sustaining polymerisation "front" (i.e. a distinct separation between hot, formed polymer and cold monomer resin that can subsequently progress through the part, allowing for nearly complete polymerisation in seconds to minutes. Control of the local heat balance, i.e. the generated heat of polymerisation that is counterbalanced by thermal diffusion and heat losses to the ambient environment and potential inert second phases, has been identified as a crucial parameter for successful frontal polymerisation and should be optimised for each specific application.

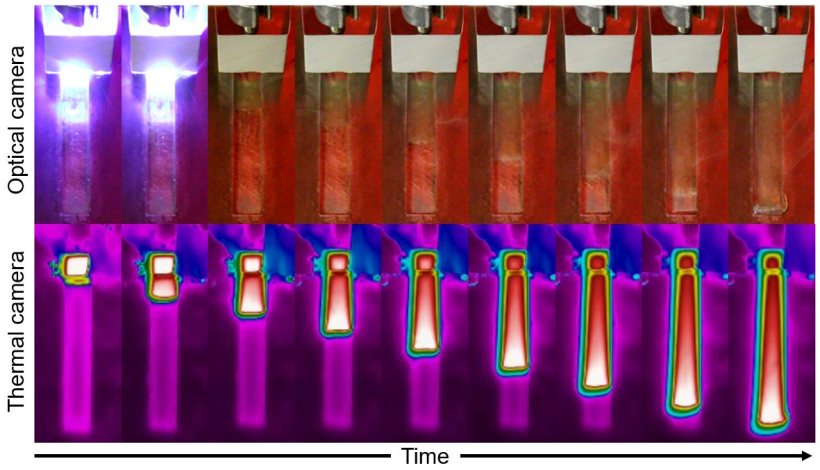

Figure 1 Typical frontal polymerisation progression captured by optical and thermal cameras.

While in recent developments have mainly aimed at an optimisation of the chemistry of frontal polymerisation, the LPAC is actively working on its implementation on larger scales and improved strategies to control the local heat balance and thereby frontal polymerisation, which are aimed to help frontal polymerisation transition to an industrial composite processing technique. The LPAC currently focusses on three main subjects related to frontal polymerisation that can be the topic of master thesis works: composite processing, process modelling and additive manufacturing. Exact topics are to be defined in agreement with the student and interested students are invited to contact Jeroen Staal (jacobus.staal@epfl.ch) to receive a more detailed introduction on the recent work of LPAC or in case of any other questions.

[1] I.D. Robertson, M. Yourdkhani, P.J. Centellas, J.E. Aw, D.G. Ivanoff, E. Goli, E.M. Lloyd, L.M. Dean, N.R. Sottos, P.H. Geubelle, J.S. Moore, S.R. White, Rapid energy-efficient manufacturing of polymers and composites via frontal polymerization, Nature. 557 (2018) 223–234.