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Application of Vinylcarbonates as Low-Toxic Monomers in Digital Inkjet Inks

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Abstract

During the last decade, the research on digital inks has seen a strong increase with the focus to bring this technique into new markets. In this regard, many experts predict huge market potential for ink-jet inks for printing on food packaging, textiles and garments. However, commercially available inks contain noxious substances or solvents, which limit or completely prevent their application in these specific fields. Especially, UV- curable inks that offer unique advantages such as instantaneous drying, the absence of VOCs, good adhesion on substrates and excellent film forming properties consist of precarious monomers mainly based on (meth)acrylates.[1]

One remarkable drawback of (meth)acrylates is their comparably high irritancy and even cytotoxicity in their uncured state.[2] This disadvantageous behaviour can be mainly attributed to the reactivity of the acrylate double bond towards Michael Addition reactions with amino- or thiol-groups of proteins or DNA. This fact together with the incomplete curing behavior of (meth)acrylates prevents their usability for substrates which are in contact with food or the human body.

Recently, several radical curable functionalities such as vinylcarbonates, vinylesters and vinylcarbamates have been introduced as interesting alternatives to (meth)acrylate based resins providing a significant lower cytotoxicity.[3,4]

The focus of this work was to evaluate vinylcarbonates as reactive building blocks in UV- curable digital inks in order to overcome the health issues which are related to (meth)arylates. For that purpose, a multitude of vinylcarbonate monomers was synthesized and studied regarding their reactivity, conversion and printability.

Although, the viscosity and surface tension of these monomers are appropriate for ink-jet printing, the curing speed is far too low for high speed printing processes. One possibility to circumvent this limitation is to use thiol-vinylcarbonate formulations offering reactivities and double bond conversions (DBC) similar to those of acrylates. For that purpose, a multifunctional thiol was synthesized providing low odour and also an appropriate low viscosity facilitating the formulation of pigmented ink-jet inks. These basic digital inks offer an excellent jetting behaviour (see Figure 1) together with good film forming properties and adhesion on PET. Ongoing experiments concentrate on the storage stability of this system to allow the implementation of these thiol-vinylcarbonate inks in industrial printing processes.

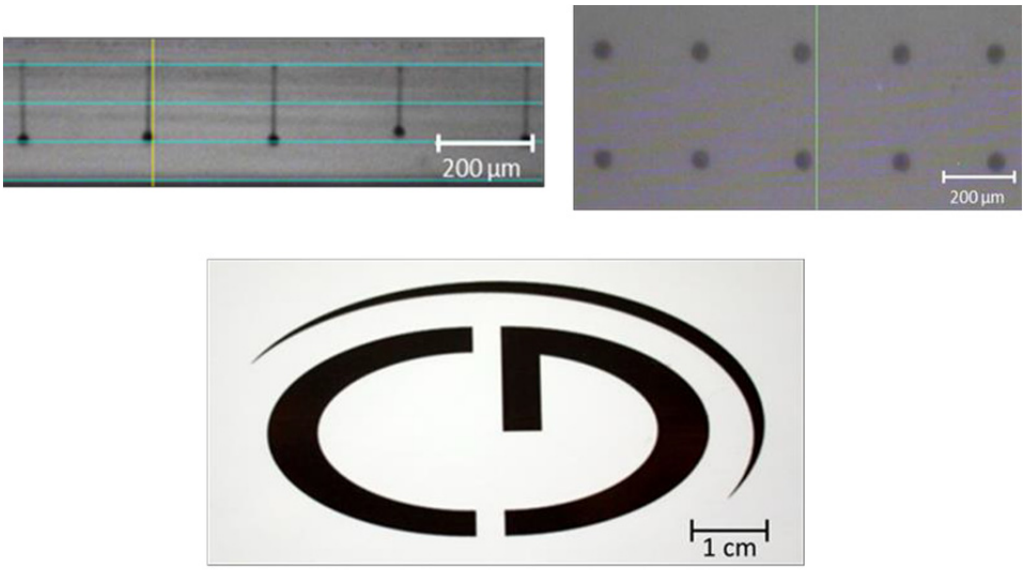

Figure 1. *Top left: images of the formed droplets 50 µs after actuation; top right: single droplet test; bottom: print on photo paper (Epson photo paper glossy)[5]*

Keywords
Vinylcarbonates, UV-curing, inkjet ink

Biography
Matthias Edler obtained his master's degree in chemistry at the Graz University of Technology (Austria) in 2008. He finished his PhD under the supervision of Prof. Dr. Wolfgang Kern (Montanuniversitaet Leoben, Austria) in 2012 with the focus on the modulation of materials properties of thin surface layers by means of UV-light. He continued his work with Prof. Dr. Thomas Griesser as project manager of the inkjet group at the Christian Doppler Laboratory for Functional and Polymer Based Ink-Jet Inks in cooperation with Durst Phototechnik DIT GmbH. The topics include development and characterization of inkjet inks.

References
[1] S. Magdassi, The chemistry of inkjet jets, World scientific **2009**.
[2] J. R. Nethercott, R. Nosal, Cont. Dermatitis **1986**, 14, 280.
[3] B. Husár, R. Liska, Chem. Soc. Rev. **2012**, 41, 2395.
[4] C. Heller, M. Schwentenwein, G. Russmüller, T. Koch, D. Moser, C. Schopper, F. Varga, J. Stampfl, R. Liska, J. Polym. Sci. A Polym. Chem., **2011**, 49, 650.
[5] F. H. Mostegel, Exploring thiol-based chemistry for photopolymerizable inkjet inks and for advanced surface functionalization, PhD thesis, **2015**.