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Process development impact on UV curing inks: An overview!

Development, Procurement and production of equipment for OEM partners i.e inkjet printers.

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Our Supply Chain

Company history

- 2003 Company launch
- 2007 Production entry
- 2017 Spin-off

Team

- Development & staff providing
- Logistics and production
- Purchasing
- Administration
- Leadership team
- Sales
- Quality management
- Apprentices

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Validation of UV curing ink processes

The validation of UV curing ink processes from a development point of view must be done in an engineered way to be successful. Often the designs of such processes are more driven by available space, price or simplifying of the system. The presentation is an introduction to the UV curing theme for validatable processes, as they are mandatory in the food and pharma industry.

Restriction

The following presentation is dedicated to UV curing inks for inkjet applications and cannot be transferred to other printing technologies.

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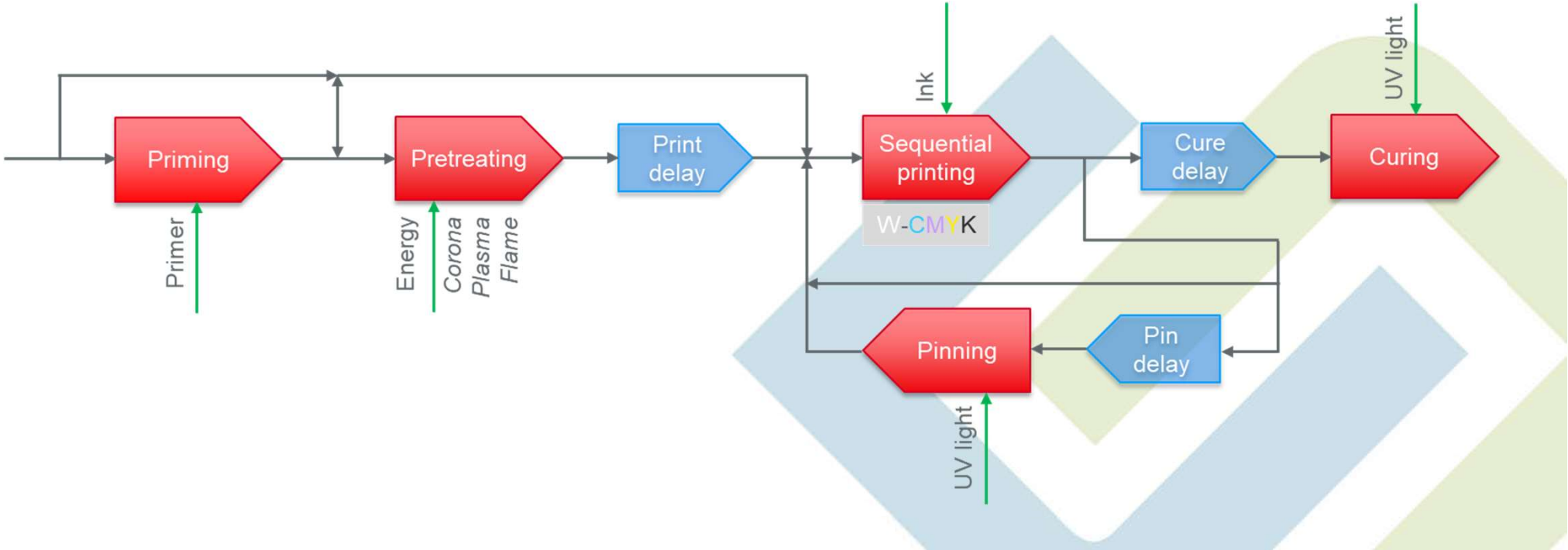
Inkjet printing process with UV curing inks

UV inkjet printing process with no claim of completeness



Priming

There are substrates that have to be primed for moving the free surface energy more close to the UV curing ink. Especially aluminum foils, metallic substrates, and some plastic materials are affected by this issue. The application with UV curing inks must be tested on the specific primed substrates to qualify the adhesion. Never the less the proper curing is key for the adhesion on the substrate and the base for the migration test.

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Pretreating

A surface pretreating of a substrate is required to increase the polar structure for getting a better adhesion of the UV curing ink. There are different pretreatments possible like Corona, Plasma, Flame and so on.

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Inkjet printing with UV curing inks

UV curing inks normally must be heated up to reach the required viscosity for the jettability of an inkjet head. Only a stable head temperature can guarantee also a repeatable drop volume. Instable ink temperature can create ink layer thickness variations and this could be an issue in the color density, polymerization grade and migration qualification.

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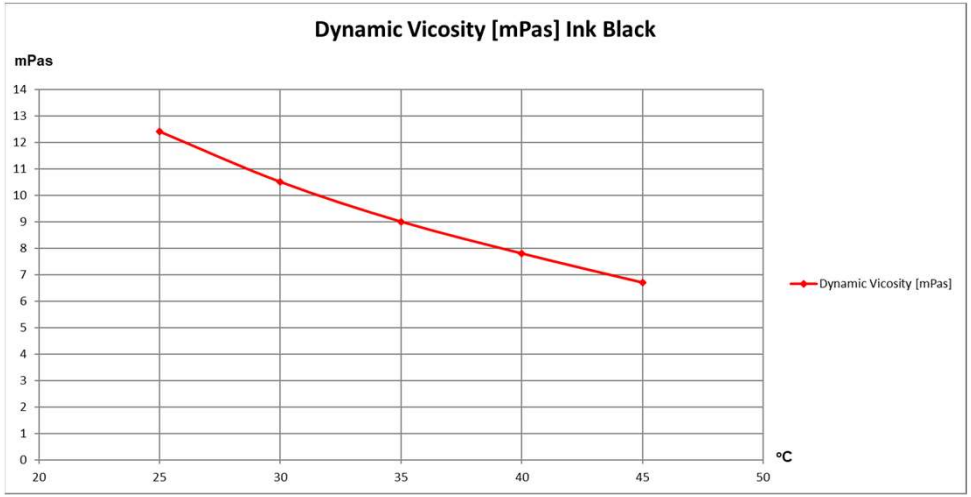
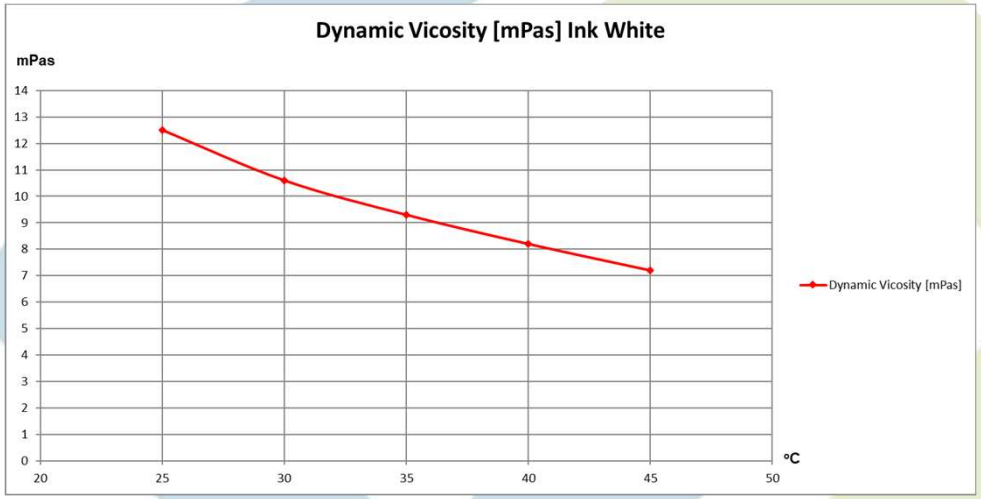
Drop volume variation of inkjet print heads

A high throughput of ink in an inkjet head could create ink temperature variations related to the thermistor position.

Drop volume variations (layer thickness) are the consequence.





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Drop volume variation of inkjet print heads

Basic resonant frequency equation:

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{rigidity}{inertia}} = \frac{1}{2\pi}\sqrt{\frac{1}{s^2}} = \frac{1}{s}$$

A higher ink density will be less affected by temperature to drop volume variations.

Temperature impact on inkjet print head chambers:

The liquid properties within inkjet print head chambers of only a few microns space differ from the liquid properties in larger spaces. The ratio of the liquid surface to its volume is very large in these small dimensions and therefore surface tension, heat transfer and viscosity have a greater impact.

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Pinning of UV curing inks

If we have a wet on wet printing a pinning is not required (CMYK). If we have additional colors like a white jetted background or a top lacquer than we have to use a pinning between the white and CMWK and the top lacquer. The pinning should create only a small skin to keep the reactivity of the ink on a high level.

Final curing of UV inks

General parameters of the following comparison:

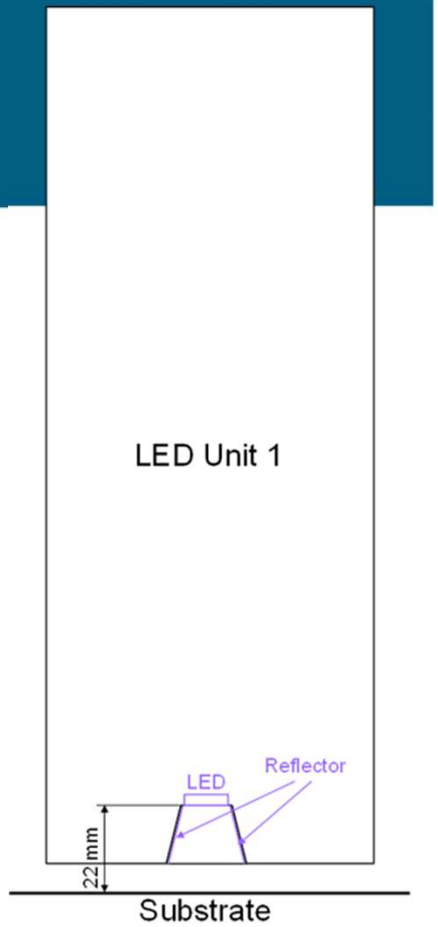
- **Primed aluminum foil as substrate**
- **Magenta (magenta ink is a difficult ink in polymerization grade, related to competitive UV light absorption of photo initiators and pigments and shows not the ink quality)**
- **Layer thickness 8 µm**
- **Remaining double bonds measured by FT-IR spectroscopy**

Impact of UV energy on polymerization

Reciprocity Error

- The Reciprocity Error of $i = f(I * t)$, i.e. (8 W * 50 ms) ≠ (16 W * 25 ms)
- Increasing of (*I*) and decreasing of (*t*) to the same product creates not the same chemical reaction
- $i = f(I * t^{(TRConst)})$ compensates the reciprocity error (TheilerRrahimiConst = 1.2 …1.7)

Reciprocity error impact on polymerization



- Wavelength **395 nm**
- Active LED window **12 mm**
- LED Power **16 W/cm²**
- Size 235 x 90 x 77 mm
- Distance LED to Substrate **22 mm**
- 165 mJ/cm² [Ws/cm²] counted on the LED
- Maximum LED power calculated to 70 m/min

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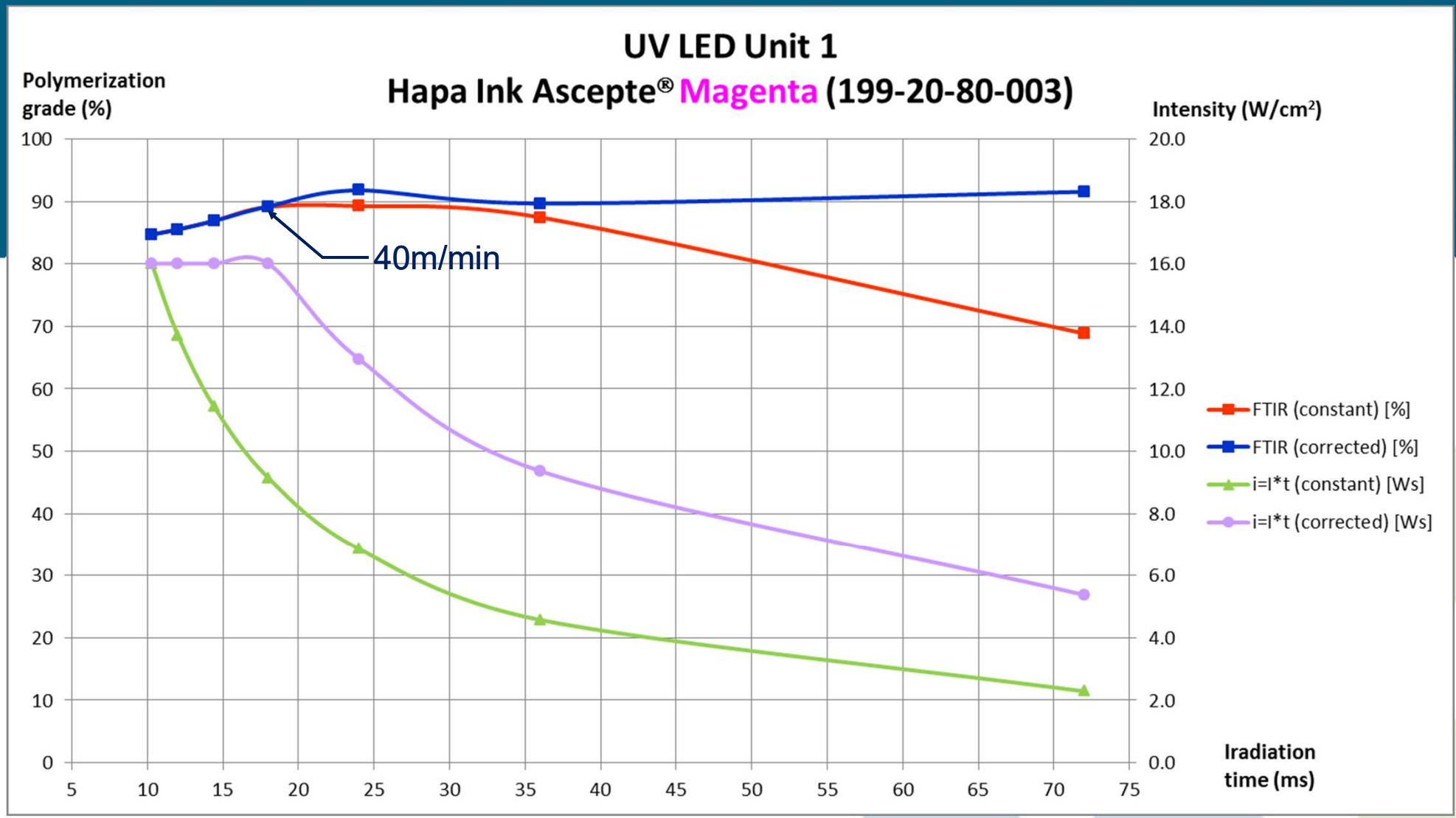
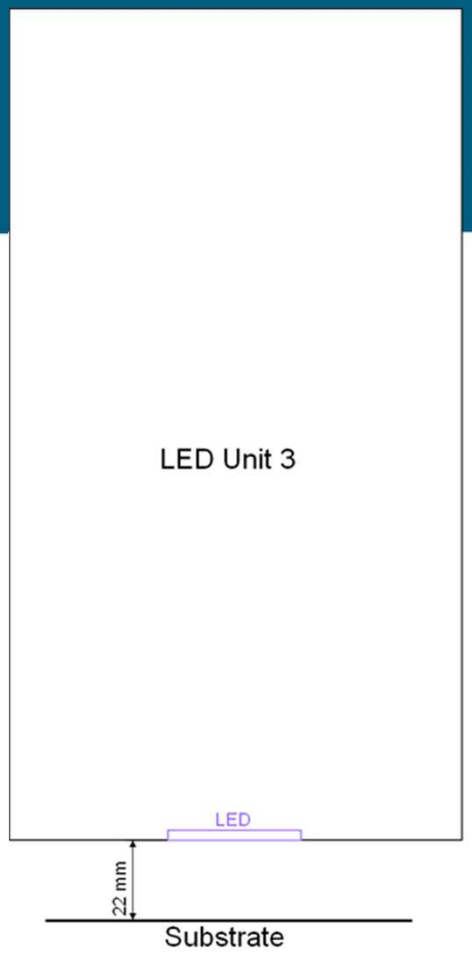
Reciprocity error impact on polymerization



Reciprocity error impact on polymerization



- Wavelength **395 nm**
- Active LED window **40 mm**
- LED Power **8 W/cm²**
- Size 250 x 136 x 77 mm
- Distance LED to Substrate **22 mm**
- 273 mJ/cm² [Ws/cm²] counted on the LED
- Maximum LED power calculated to 70 m/min

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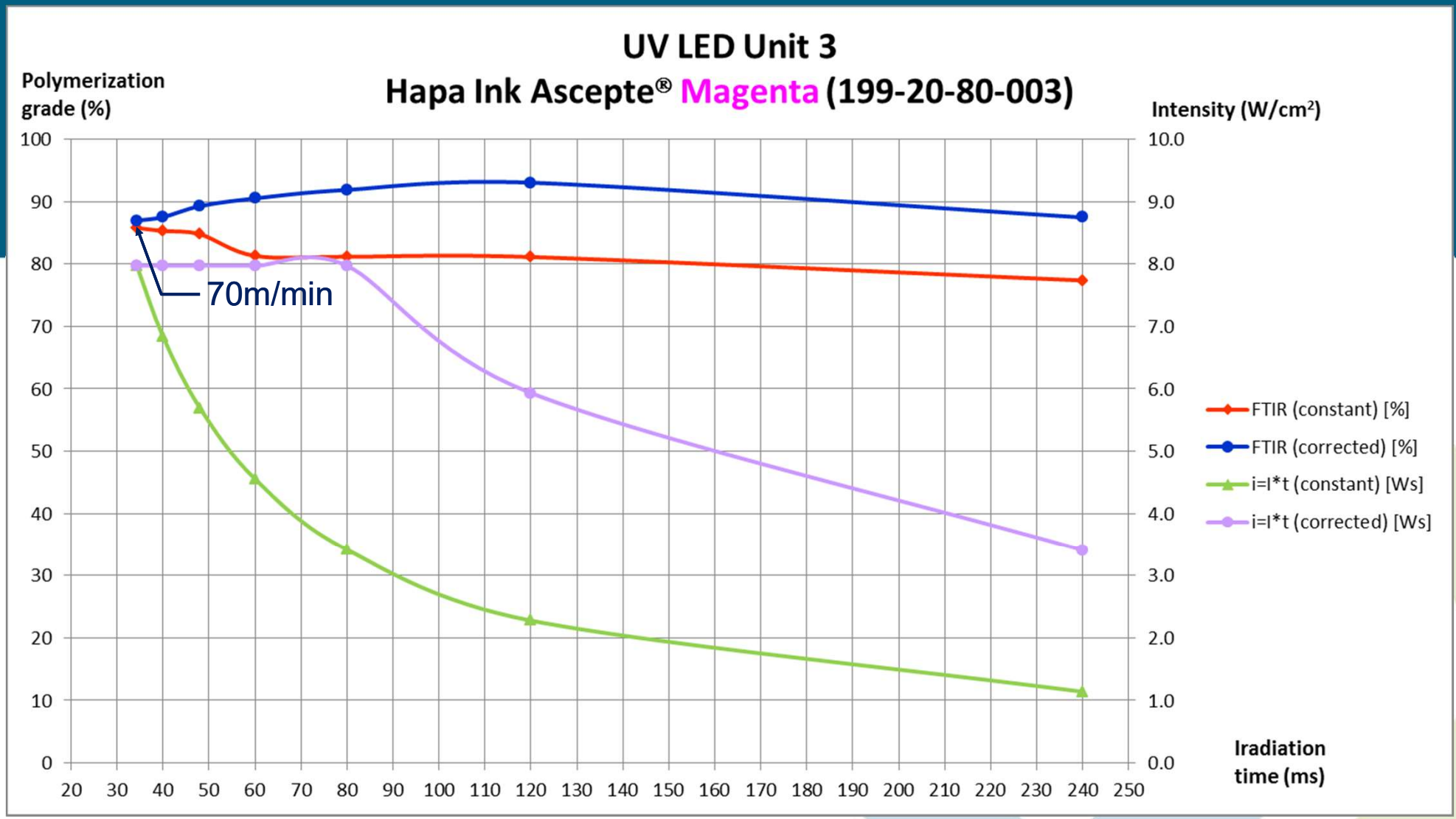
Reciprocity error impact on polymerization



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Thank you!

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