Master's Thesis Engineering Technology

2021-2022

Investigating surface pre-treatment and diamond nano-seed deposition on glass by ultrasonic spraycoating and inkjet printing for industrial applications

Jeunen Ewoud

Master of Electromechanical Engineering Technology

Thomas Seppe

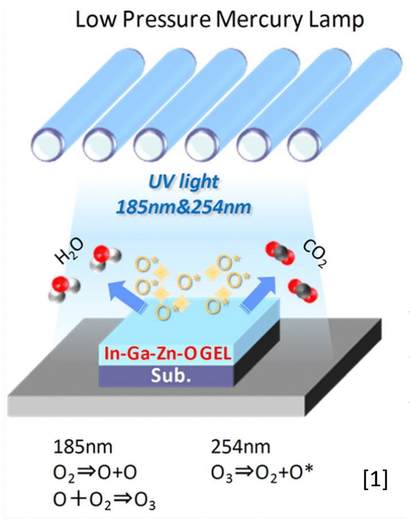
Master of Electromechanical Engineering Technology

Surface pre-treatment on fused silica glass substrates

A surface treatment → improving surface conditions

UV-Ozone treatment

Low Pressure Mercury Lamp



185nm $O_2 \Rightarrow O+O$, $O+O_2 \Rightarrow O_3$

254nm $O_3 \Rightarrow O_2+O^*$

[1]

- Duration: 15-120 minutes

\+ Removes organic contaminents

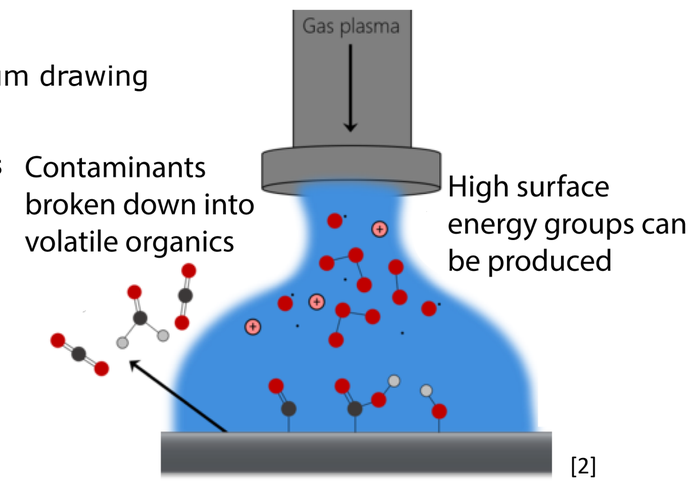
\+ Basic lamp system

– Inorganic contaminants remain

– Staining and discoloration

– Precleaning needed

O_2-Plasma treatment



[2]

- Duration: 1-3 minutes + vacuum drawing

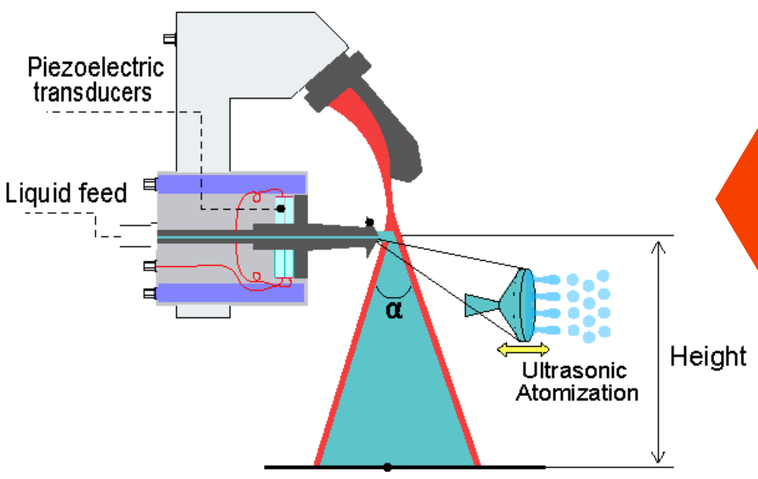
\+ Removes organic contaminents

– Expensive vacuum system

– Etches surface deeply

– Degrades rapidly

Ultrasonic spraycoating



\+ Uniform small droplets (± 25 µm)

\+ Pressureless atomization resulting in low impact speed

\+ Multiple nozzle types

\+ Ultrasonic vibration keeps dispersions and solutions homogeneous dissolved

\+ Multiple controllable parameters

– No fine patterns

– Multiple layers (± 120)

– Non-uniform coverage when overlapping

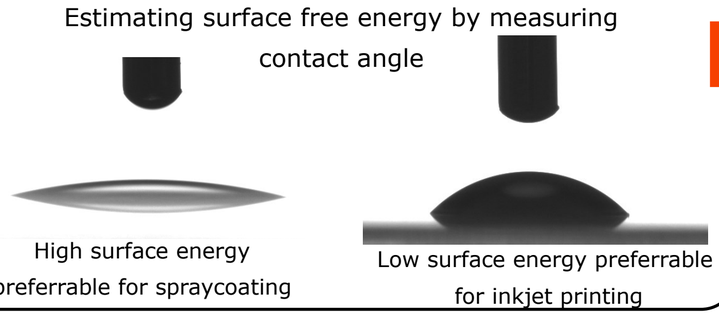
Used for coating areas

Methodology

3 sets of samples for each pre-treatment method during a period of 21 days, samples are printed and spraycoated

Contact angle measurement

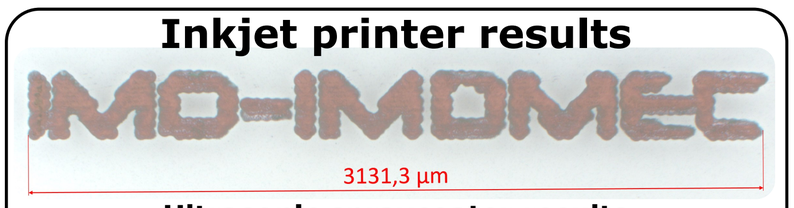
Estimating surface free energy by measuring contact angle



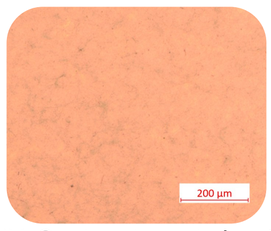
High surface energy preferrable for spraycoating

Low surface energy preferrable for inkjet printing

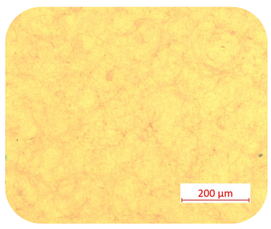
Inkjet printer results



Ultrasonic spraycoater results

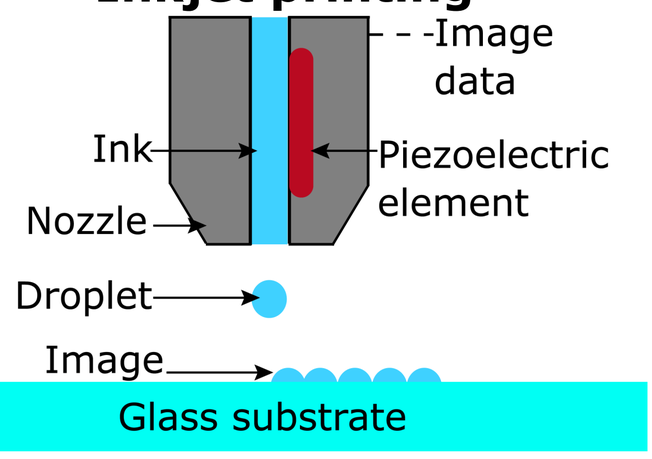


UV-O_3 treatment day 3



O_2-plasma treatment day 3

Inkjet printing



\+ High resolution (± 30-50 µm)

\+ Flexible patterning

\+ Low ink consumption

\+ Clean working conditions

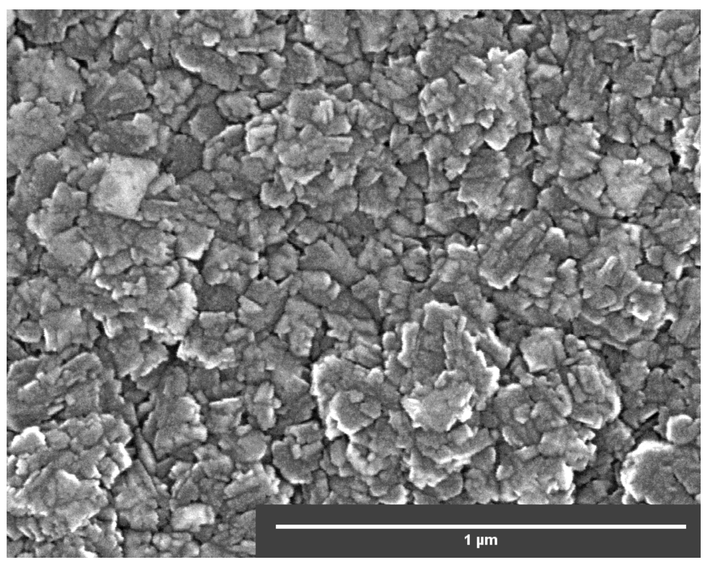
– Slow process

– High fail rate

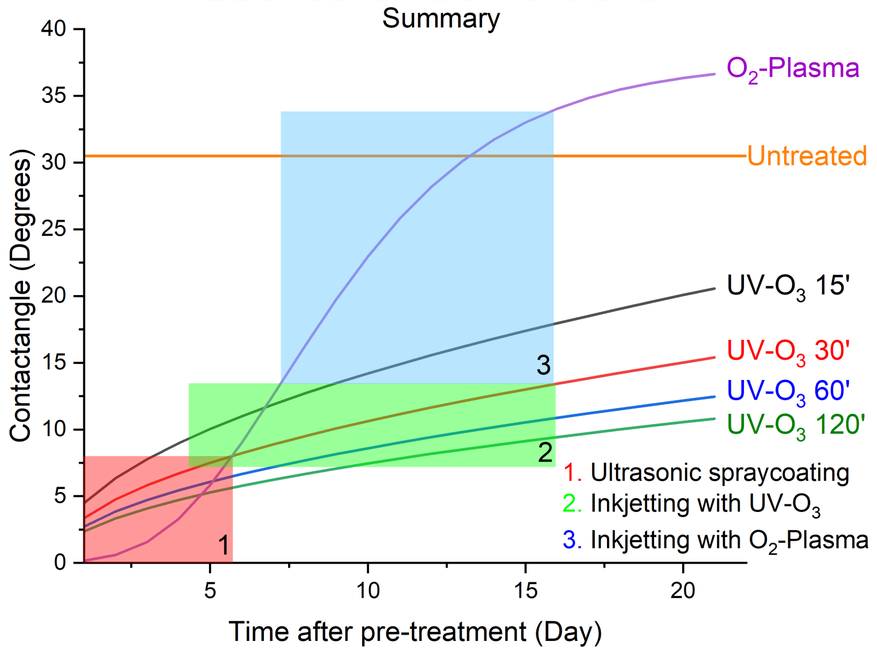
– Very strict ink formula

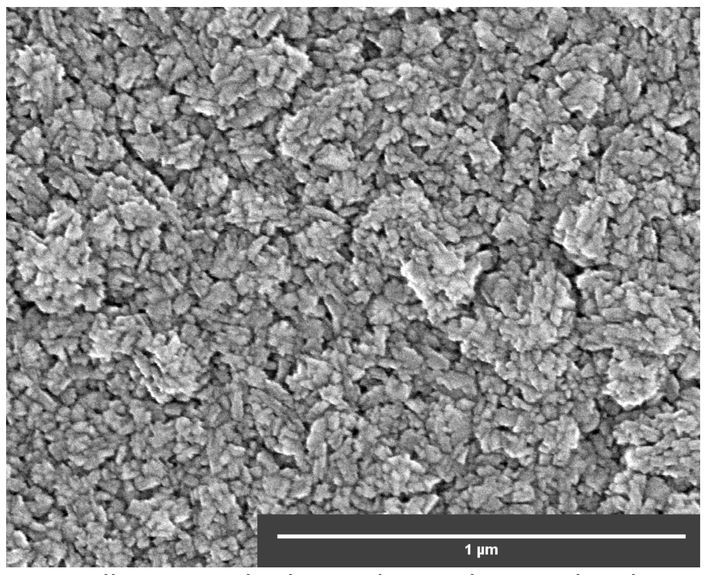
Used for printing fine patterns

Results & conclusion



Fully covered spraycoated sample visualized by scanning electron microscope





Fully covered inkjetted sample visualized by scanning electron microscope

Supervisors / Cosupervisors: Prof. Dr. Ir. Wim Deferme & Ing. Pieter Verding

[1] K. Umeda, T. Miyasako, A Sugiyama, A. Tanaka, M. Suzuki, E. Tokumitsu, T. Shimoda, "Impact of UV-O_3 treatment on solution processed amorphous $InGaZnO_4$ thin-film transistors","Journal of Applied Physics",2013, 10.1063/1.4804667.

[2] E. Spooner, "A Guide to Surface Energy", Aug. 2020, https://www.ossila.com/pages/a-guide-to-surface-energy

IMO-IMOMEC UHASSELT imec

UHASSELT KU LEUVEN