INKJET PRINTING OF TRANSPARENT CONDUCTING OXIDES

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INTRODUCTION

Transparent conducting oxides are materials with a band gap above 3.3 e.V. and free charge carriers. Their advantages consist of low cost of raw material compared to noble metals, homogeneity of properties and high electrical conductivity associated with a high optical transmittance.
Current applications are:

- Solar cells
- LEDs and displays
- Anti-static coatings
- Electrochromic and smart windows

STATE OF THE ART

State of the art transparent ITO conductors are vacuum deposited and further multi step etched, generating waste and extra costs. Another approach is the development of silver and gold metallic grids but they are fragile, oxidizes or have high raw materials costs

INM OBJECTIVE AND APPROACH

- A direct digital contactless printing over flexible substrates
- Formulation of TCO inks (In_2O_3:Sn, ZnO:Al, ZnO:Si and TiO_2:Nb) with already conductive nanoparticles and a polymeric system to increase their packing under low temperature UV curing

INKJET PRINTING

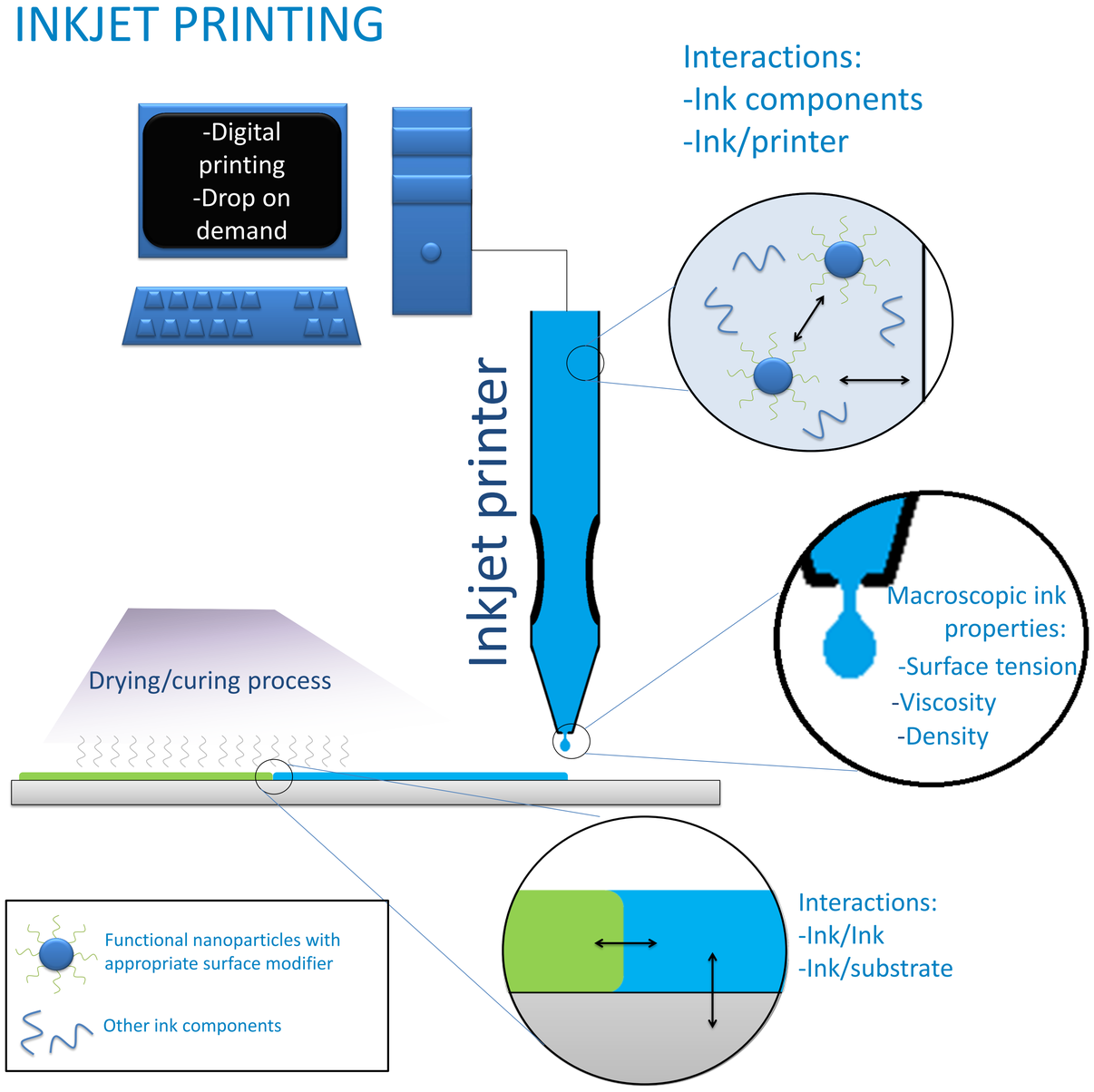

Fig. 1: Challenges and important aspects that affect coating functionality in inkjet printing

INK STRATEGY

Distinction between synthesis of the conductive nanoparticles and their deposition → low temperature processing → flexible substrates
Spatial homogeneity of particle distribution

- Induced Marangoni flows
  - Mixture of solvents
    - Different boiling points
    - Different surface tensions
- Management of spatial solvents evaporation rate

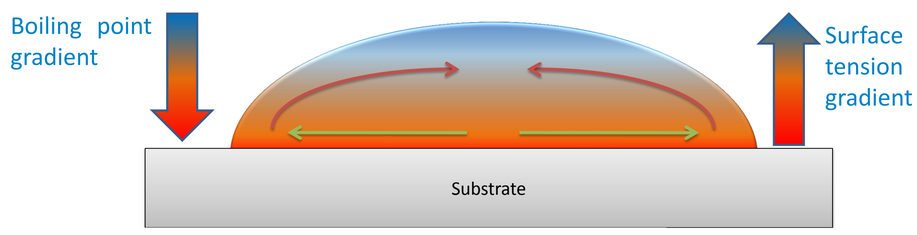

Fig. 2: Induced flows during lines solvents evaporation

RESULTS

- Flexible lines with up to 120 nm thickness
- Curing temperature below 120 °C
- Suppression of coffee ring effect
- Improved optical and electrical properties
- Various substrates (glass, PC, PET, PMMA, paper)
- Sheet resistance around 5kΩ/sq

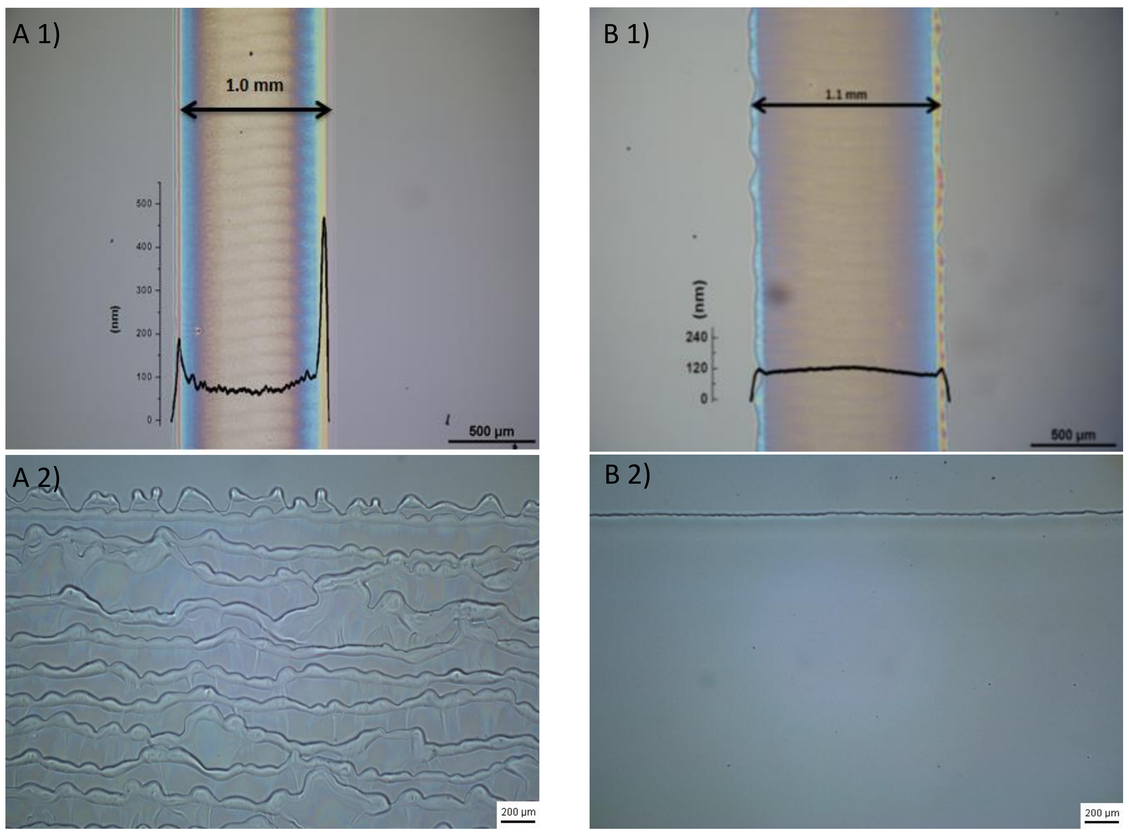

Fig. 3: Suppression of coffee ring effect by management of spatial solvent evaporation

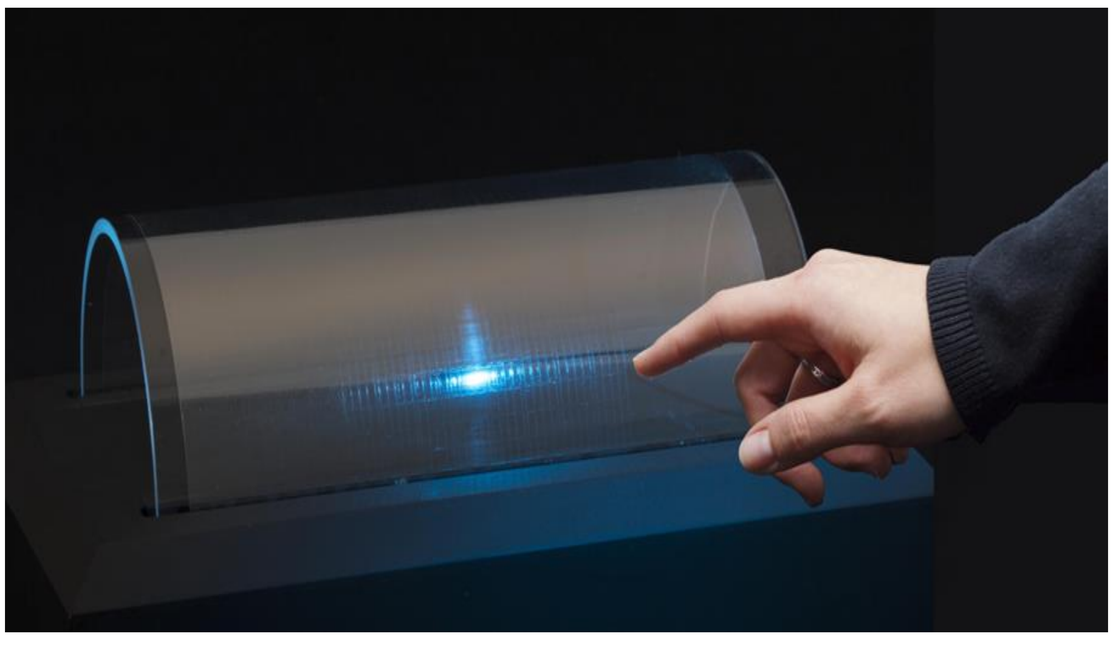

Fig. 4: Functional inkjet printed ITO flexible multi touch panel

OUTLOOK

- Increase printing resolution on non-porous substrates
- In addition to particle spatial distribution, manage ink wettability
- Transfer technology to various TCO systems (ZnO:Al, ZnO:Si and TiO_2:Nb)
- Improve electrical properties of the lines

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 641927

European Commission

Member of the Leibniz Association