XIV Giornata della Chimica dell'Emilia Romagna

Società Chimica Italiana

18 dicembre 2014
Università di Parma

University of Modena and Reggio Emilia

PhD "MODELS AND METHODS FOR MATERIAL AND ENVIRONMENTAL SCIENCES"

"Chemical characterization of inks for inkjet decoration of ceramic tiles"

Ferrari G.[a], Zannini P.[a]

[a]*University of Modena and Reggio Emilia, Department of Chemical and Geological Sciences, via Campi 183, 41125, Modena*

Introduction and aims of the study

Inkjet technology is well-known because of its application to home printers, polymers deposition, etc. From 2001, this technology has been applied to ceramic tiles decoration, and nowadays it is the most widespread method in this field.

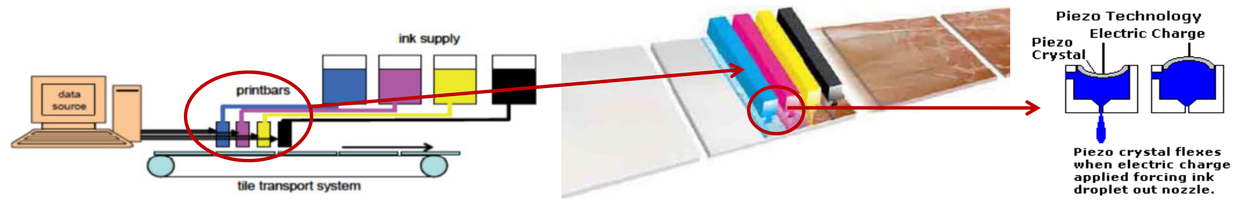
Inks for ceramic tiles decoration are characterized by:
- ***A solid pigment***: mainly, a grounded mineral component
- ***A dispersing phase***: mix of organic compounds that keep the solid phase in suspension and allow inks printability

PROS:

- ❑ No storage problems
- ❑ Unlimited decoration possibilities
- ❑ Expanded surface of decoration
- ❑ Non-flat surfaces can be now decorated
- ❑ …

CONS:

- ❑ Specific rheological properties
- ❑ Chromatic performance of micronized pigments
- ❑ Inks sedimentation/nozzles occlusion
- ❑ Polluting emissions of inks

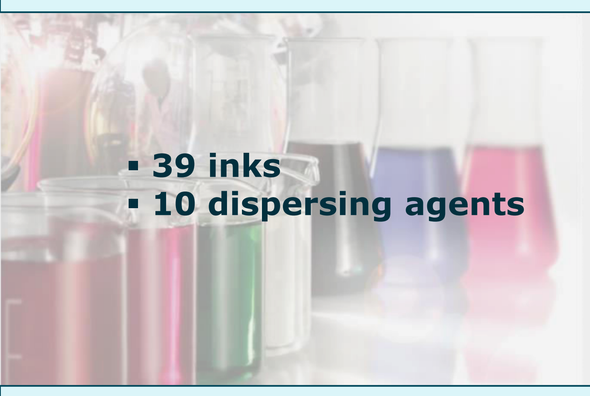


Drop-on-demand (DOD): the deposition of inks on ceramic tiles surface, drop by drop, and only when it is required by a control software.
Drops are produced in piezoeletric nozzles, by an electric impulse that deforms the nozzle itself.

Most of the cons depend on the **formulation of the dispersing phase**.

So, the aims of this PhD project are:
- ➢ *chemico-physical characterization of inks in commerce*
- ➢ *rheological study of their technological properties*
- ➢ *chemical characterization of polluting emission during firing*
- ➢ *possible reformulation of inks*

Samples and Analytical Techniques



- **39 inks**
- **10 dispersing agents**

Chemical characterization:
- ➢ *FT-IR Spectrometry:* dispersing phase on liquid samples, between NaCl disks
- ➢ *X-Ray Fluorescence:* coloring phase directly on liquid samples

Thermal behavior:
- ➢ *TG-DTA*

2 measurements for each sample:
- 20°-700°C, 5°C/min
- 20°-700°C, 50°C/min

Polluting emissions during firing *(in progress)*:
- ➢ *Sampling of emissions during firing in a tubular kiln*
- ➢ *GC-MS*
- ➢ *HPLC*

Reological properties *(in progress)*:
- ➢ *Viscosimetry*
- ➢ *Surface tension*
- ➢ *Density*

Results and Conclusions

TG-DTA

- ❑ ***different dispersing agents showed different thermal behaviors***

In Fig.1:
paraffin oil (solid lines): a single weight loss, correlated to an endothermic reaction.
2-ethylhexyl-stearate (dashed lines): a single weight loss, in correspondence of an exothermic reaction.

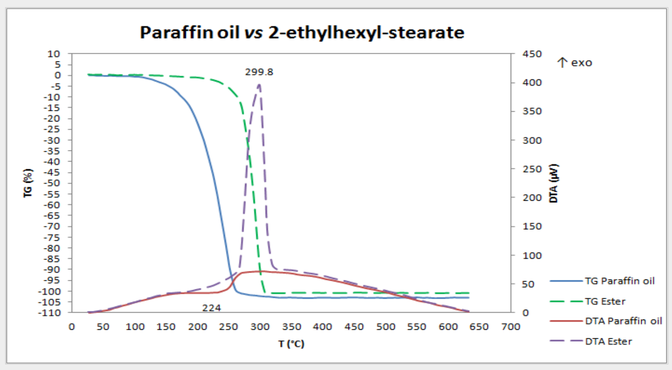


Fig.1

- ❑ **27 inks showed intermediate behaviors: 2 major weight losses (endothermic + exothermic)**

In I11 TG-DTA graph (Fig.2) :
- A first weight loss (-21.4%) in correspondence of an endothermic reaction, with its minimum at 259.4°C.
- A second weight loss (-33.7%) correlated to an exothermic reaction, around 313.7°C.

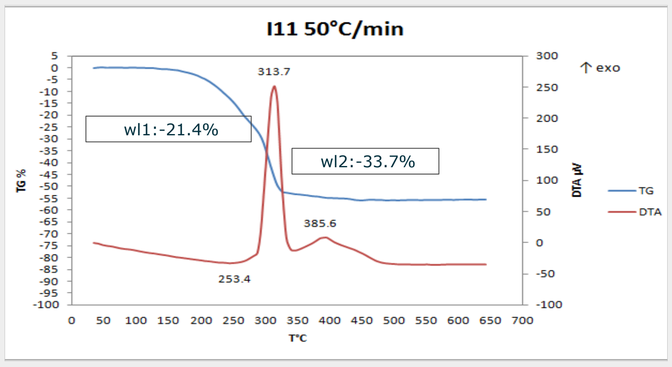


Fig.2

FT-IR

- ❑ **a first identification of organic compounds classes in dispersing agents and inks**
- ❑ **a first comparison between dispersing agents and inks**

XRF

XRF results agree to literature data.

Just 2 samples showed unusual composition.
I4 (a yellow ink) (Fig.3) has a coloring phase completely different from common *zircon*-based yellow inks.

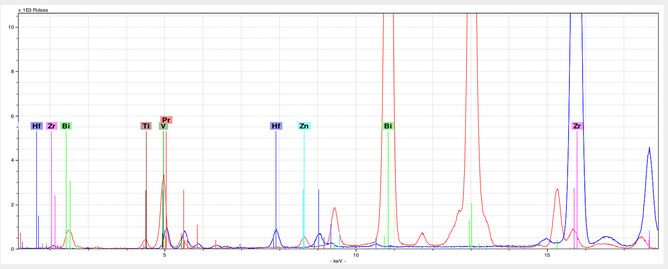


Fig.3 - I4 (red) vs. I2 (blue)

Conclusions

- ❑ **We divided our samples in 5 group, depending on their dispersing phase composition:**

1) Paraffin oil
2) Esters
3) Paraffin oil added with esters
4) Tripropylene glycol n-butyl ether (TpnB)
5) Water added with paraffin oil

- ❑ **For inks with intermediate thermal behavior, we hypothesized a dispersing phase composed of *Paraffin oil* and *one Ester*.**

Future steps..

- ✓ Preparation and characterization of several mix of dispersing agents, for further FT-IR and TG-DTA analyses and comparison with data collected so far.
- ✓ A collaboration with ISTEC-CNR, in Faenza, to perform reological studies. These properties will be correlated to inks chemical composition.
- ✓ Development of GC-MS and HPLC methods, together with Studio Alfa in Reggio Emilia, to study polluting emissions