Open-source developments for Office Chromatography

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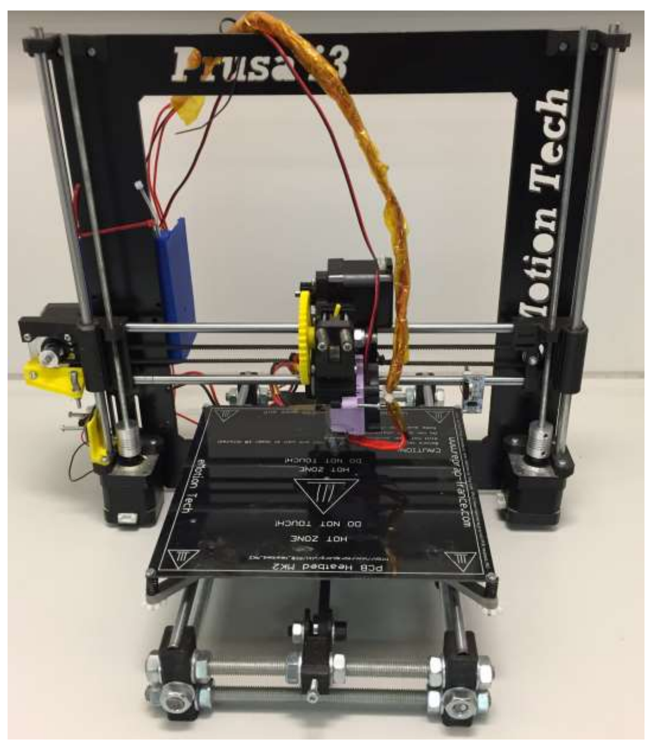

Fig. 1 Original 3D printer

Highlights

- *Office Chromatography (OC) aims at combining all steps of miniaturized planar chromatography in a single device [1, 2].*
- *A self-mounted, open-source 3D printer (Fig. 1) was modified to explore the OC concept.*
  - *A slurry doser was designed for printing of silica gel layers [3].*
  - *The implemented fully controlled inkjet application of samples and mobile phases solved previous limitations [4].*
- *A single software dedicated to analysts was developed to control all steps.*
- *The 3D printing environment is suited for rapid and cost-effective prototyping of compact laboratory equipment.*
- *All designs and software were released open-source to encourage reuse and improvement [3, 5, 6].*

Printing of the layer unlimited in its shape

Hardware

- *Design and printing of slurry doser (Fig. 2)*
- *Configuration of the Marlin firmware*
- *Z level correction for plate to needle distance*
- *Heated stage for drying*

Workflow

- *Slurry recipe: 0.88 g SiO_2 + 0.12 g $CaSO_4$ + 3 g H_2O*
- *Slurry kept under agitation until printing*
- *Separation of a mixture of dyes with toluene in twin-through chamber*

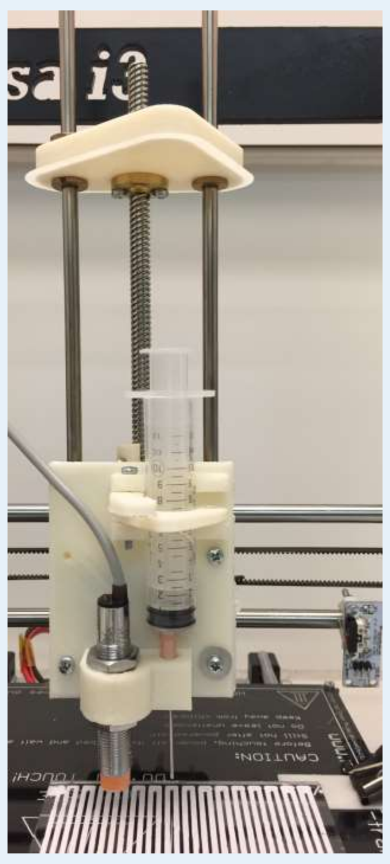

Fig. 2 Slurry doser

Results

✓ *Novel patterns possible (Fig. 3)*
✓ *40 tracks on channeled plate (Fig. 4)*
✓ *Spray application on self-printed HPTLC adsorbent (Fig. 5)*
✓ *670 Euro investment costs*
✓ *0.04-0.25 Euro depending on layer pattern*

Future work

✓ *Dedicated mechanical body*
✓ *Smaller needle diameter for UTLC*
✓ *Polymer binder for robust layers*
✓ *Quantitative studies*
✓ *SEM images of printed UTLC layers*
✓ *Contactless inkjet printing*

Fig. 3 No pattern limitation!

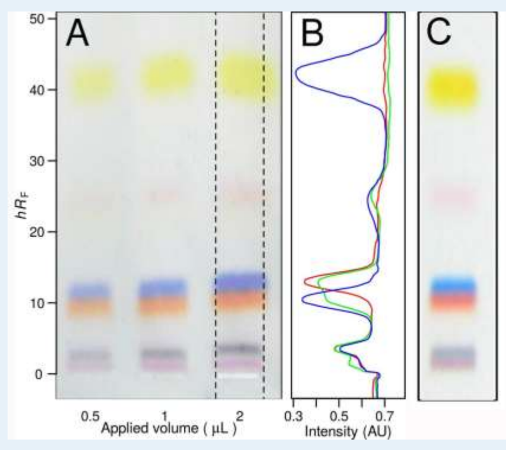

Fig. 5 Chromatograms obtained from (A) 3D printed HPTLC plate (B: respective video densitogram of the dashed track) *versus* (C) commercially available HPTLC plate.

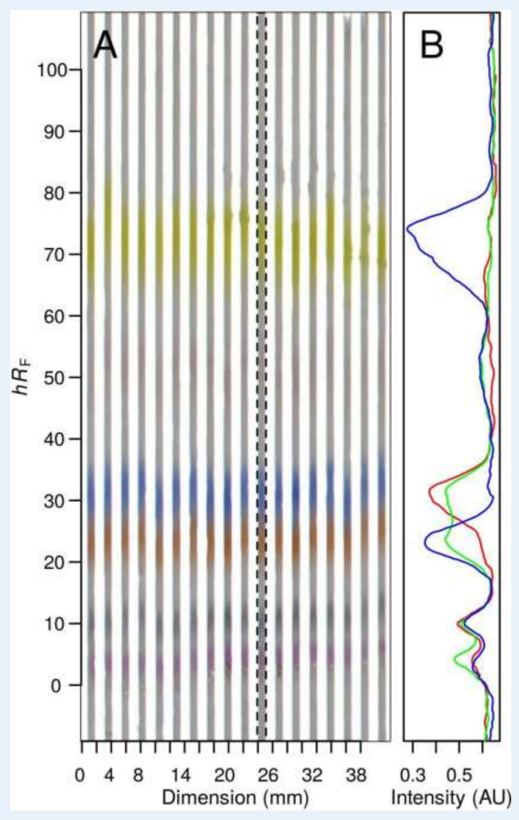

Fig. 4 Chromatograms of the channeled pattern (A) and videodensitogram (B, marked track, in ascending hR_F: Oracet Violet 2R, Solvent Blue 22, Sudan Red G, Solvent Blue 35, Oracet Red G and Dimethyl Yellow)

Inkjet printing of samples and mobile phase

Hardware

- *Integration of the open-source InkShield board*
- *Design and printing of cartridge holder (Fig. 6) and elution chamber (Fig. 7)*
- *Modification of the M700 GCODE in Marlin*
- *Preparation of HP C6602 cartridges*

Workflow

- *Dissolution of dyes in aqueous and hydro-methanolic solutions*
- *Separation of dyes on normal phase in horizontal chamber*
- *Separation of dyes on RP-18 W with printed mobile phase*

Fig. 6 Sample application via cartridge and holder

Fig. 7 Miniaturized chamber for horizontal development

Results

✓ *Inkjet application comparable to spray-on application (Fig. 8)*
✓ *Printing of hydro-methanolic mobile phase possible (Fig. 9)*
✓ *Full control highly valuable*
✓ *Resolution of 96 dpi*
✓ *Application in the nL-range*

Future work

✓ *Dedicated mechanical body (Fig. 10)*
✓ *Further solvent systems*
✓ *Other user cases*
✓ *Fragile layers (printed and UTLC)*
✓ *Derivatization*
✓ *Incubation chamber for bioassay*

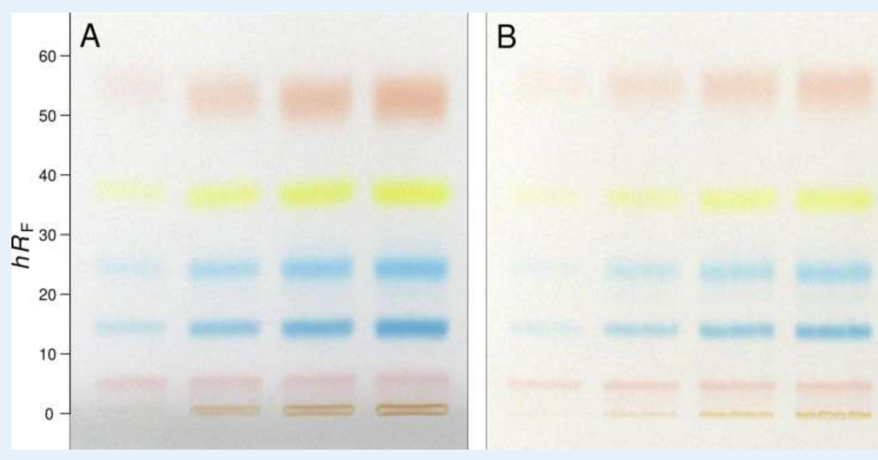

Fig. 8 Comparison of (A) spray-on application and (B) printing of a dye mixture (in ascending hR_F: E126, E142, E131, E105 and E122) separated on HPTLC plate silica gel 60 with EtOAc - MeOH - H_2O - AcOH, 65:23:11:1 [7]

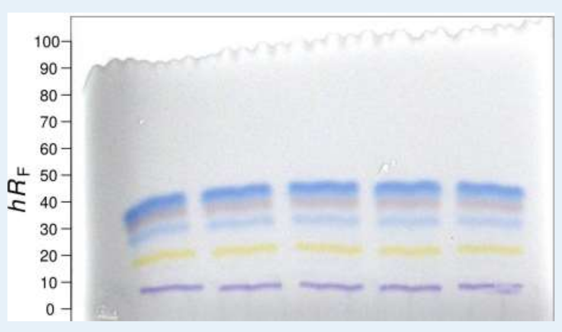

Fig. 9 Printing of both dye mixture (in ascending hR_F: E151, E110, E132*, E124 and E132) and mobile phase (MeOH - 5 % Na_2SO_4, 3:4 [8]) on HPTLC plate RP-18 W

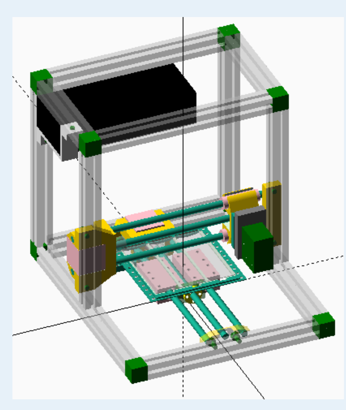

Fig. 10 Computer assisted design of a potential OC prototype

References [1] G. Morlock, J. Chromatogr. A 1382 (2015) 87-96. [2] B. Degg, LCGC The column, November 2015, 8-10. [3] D. Fichou, G. Morlock, Anal. Chem. 89 (2017) 2116-2122. [4] G. Morlock, C. Stiefel, W. Schwack, J. Liq. Chromatogr. Relat. Technol. 30 (2007) 2171-2184. [5] https://github.com/DimitriF. [6] D. Fichou, P. Ristivojevic, G. Morlock, Anal. Chem. 88 (2016) 12494-12501. [7] G. Morlock, C. Oellig, J. AOAC Int. 92 (2009) 745-756. [8] M. Werther, CBS 88 (2002) 7.

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