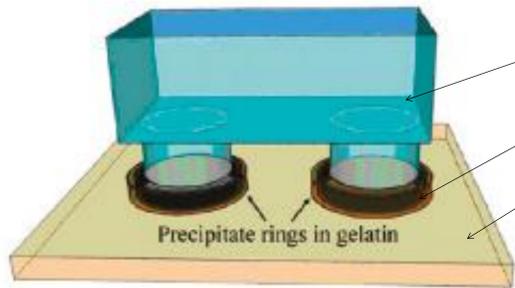


# Hematite micropatterns created by reaction-diffusion-precipitation processes

## Abstract

We use the so called wet stamping method to create hematite micro- and nanostructures. In this method a micro patterned hydrogel stamp delivers one or more reactants into a thin film of dry gel doped with a co-precipitating reactant resulting in a micro scale precipitation pattern (3). A thermal treatment of the pattern results in periodic structures of mixed metal-oxides on a ceramic surface. Hematite micro- and nanostructures can be obtained by doping the gels with iron salts or hematite nanoparticles. Hematite is an attractive candidate as a photo anode for solar energy driven splitting of H<sub>2</sub>O in photo electrochemical cells due to its abundance, low cost, chemical stability in aqueous environment and suitable band gap. However, hematite has a short hole diffusion length, therefore micro- and nanostructuring its morphology is a great interest.

## Pattern Preparation: Wet Stamping Technique



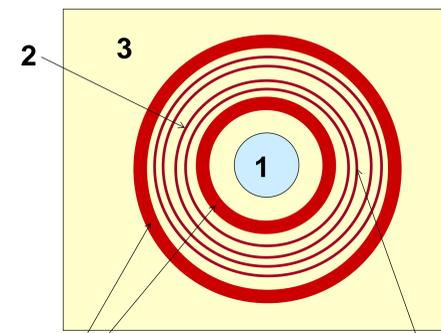
*J. Phys. Chem. Lett.*, 2011, 2, 345–349

Gelatin film is deposited by spin-coating.

- 1 – Soaked Agarose Stamp
- 2 – Precipitation rings
- 3 – Doped gelatin film

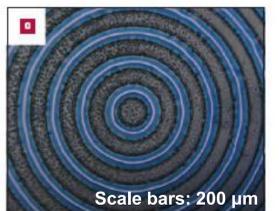
	Doping		Precipitate
	Agarose stamp	Gelatin film	
a)	AgNO <sub>3</sub>	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	Ag <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>
b)	K <sub>4</sub> [Fe(CN) <sub>6</sub> ]	FeCl <sub>3</sub>	Fe[Fe <sub>2</sub> (CN) <sub>6</sub> ] (Prussian Blue)

Secondary (thinner) rings have only been found in the Ag<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> system so far.



Primary rings

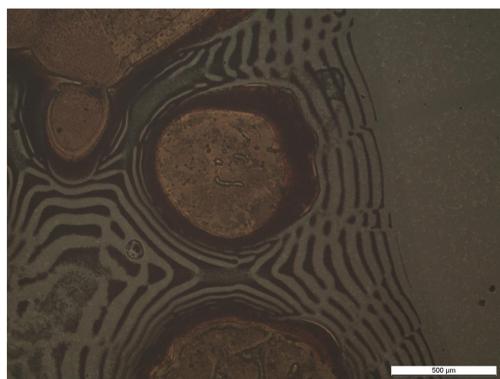
Secondary rings



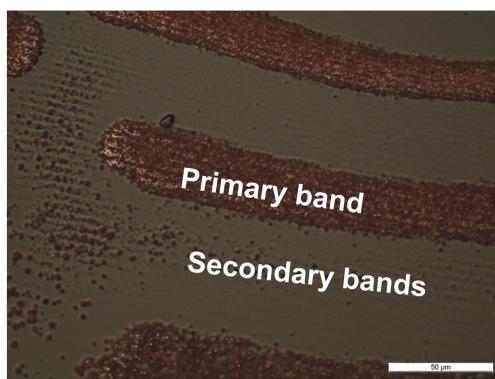
*Nature Materials*, 2004, 6, 729 - 735

## Results a) Silver dichromate structures

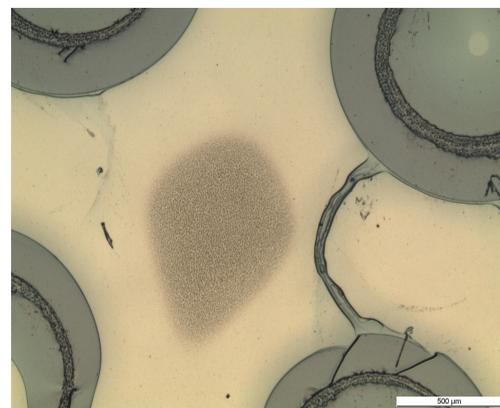
## b) Prussian blue (iron-oxide) structures



Silver dichromate pattern



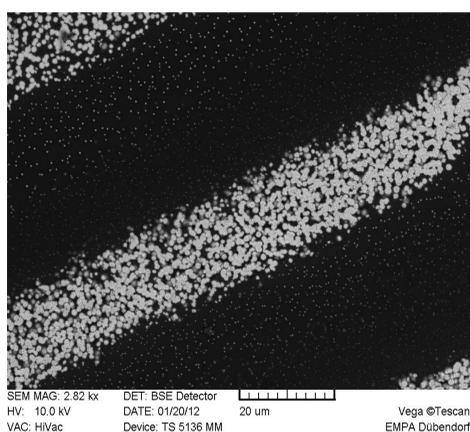
Primary and secondary bands



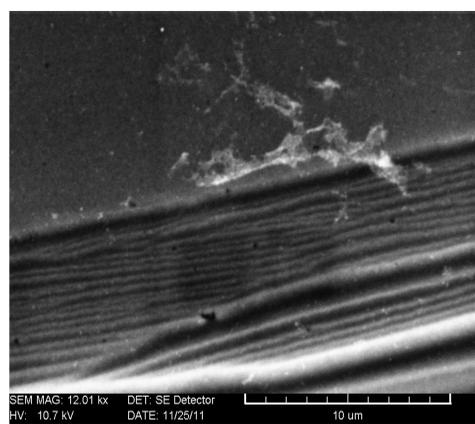
Prussian blue precipitate rings before annealing



Precipitate rings after annealing at 500°C for 90 minutes

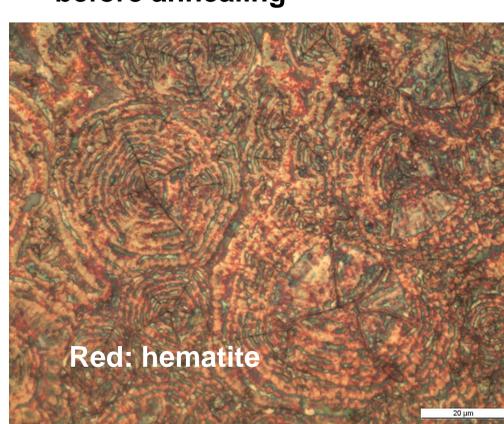


SEM MAG: 2.82 kx  
HV: 10.0 kV  
VAC: HVac  
DET: BSE Detector  
DATE: 01/20/12  
Device: TS 5136 MM  
Vega ©Tescan  
EMPA Dübendorf

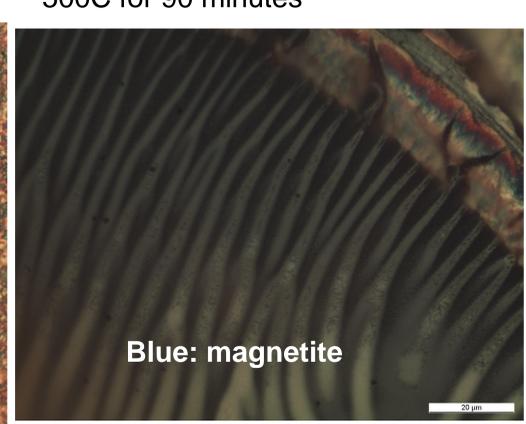


SEM MAG: 12.01 kx  
HV: 10.7 kV  
DET: SE Detector  
DATE: 11/25/11  
10 μm

SEM images of primary and secondary bands within the structures



Red: hematite



Blue: magnetite

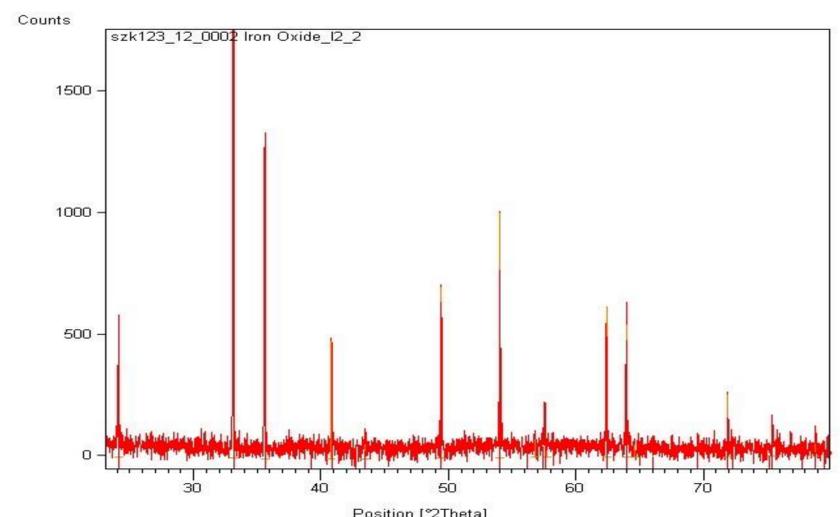
Patterns within the iron oxide structures.

## Conclusions

- Primary and secondary bands of silver dichromate are reproduced.
- Only primary precipitation bands with Prussian blue were found.
- Concentration of the salts and thickness of the gelatin film and stamp affect the width, height and wavelength of the bands.
- Thermal treatment of the films results in hematite/magnetite structures.
- The structures depend on annealing temperature and time.

## Acknowledgement

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XRD pattern shows existence of Hematite in the sample