CRACK SELF-ORDERING: FABRICATION OF NANOPOROUS PERIODIC ARRAYS OF METAL OXIDES

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ABSTRACT:

While crack formation in films is typically associated with a serious drawback, cracks create intricate and sometimes quasi-periodic patterns. Controlling the formation and propagation of cracks can thus serve as a simple and cheap patterning method. In this work, we exploit the cracking process for the facile **fabrication of micropatterned nanoporous inorganic films**. For that, we formulated aqueous-based ink composed of an inorganic phase precursor and polymeric latex nanoparticles (PNPs). The latter serve as crack directing and templating agents. During a simple dip- or blade-coating deposition PNPs form a colloidal gel which transfers the drying stress guiding propagating cracks (Figure 1a). At the same time, the gel becomes a scaffold for the co-deposited inorganic phase. The thermal treatment removes the polymer and causes crystallization of the inorganic phase (Figure 1b). The special design of PNPs surface is compatible with many different inorganic precursors. This assures high versatility of the process, which was shown by the fabrication of more than 10 different nanoporous films (e.g. TiO_2, ITO, V_2O_5, IrO_2, Ir^0). The high quality of periodic nanoporous arrays, continuing for more than several cm, allows for efficient light diffraction (Figure 1c). Therefore, they served as temperature-responsive diffraction grating sensors.

Furthermore, the fabrication of a multilayer system allows propagating cracks in 3D between layers yielding complex patterns of polygonal-shaped features and different chemical compositions at the bottom and the top (**Janus polygons**). The crack-patterning process is a valuable alternative to lithography methods, with the potential for scaling up.

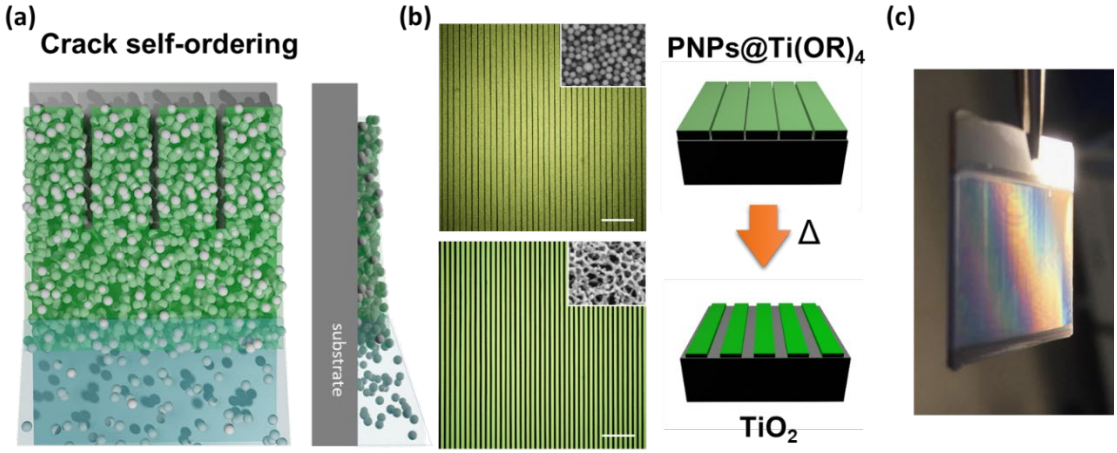

Figure 1 : Crack patterning process. (a) Schematic of crack self-ordering during dip-coating deposition; (b) optical microscope images and schematic of the as-deposited film (upper) and calcined (bottom); (c) Photograph of crack patterned TiO_2 film.

References

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2- Odziomek M, Fausitni M, Boissiere C, Sanchez C. *Ink composition for the production of micropatterns.* Patent WO 2021/130292 A1