Electric field switched surface topography of fingerprint liquid-crystal network polymer coating

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INTRODUCTION

Solar cell panels in deserts could be easily contaminated by sand after a storm. In these remote places it is not practical and economical to manually clean the panels by men. One possible solution to achieve dry self-cleaning is using switchable surface topographies to mechanically slide off the sand.

Fig. 1 Contaminated solar cell panels in the desert

Liquid crystals are widely used in displays of laptops, TVs, PDAs, etc.. Beyond displays, we employ liquid crystals in fabrication of smart stimuli-responsive surfaces. When the surface is actuated, sand on the panels is slid off due to switched surface topography and reduced friction. Preferably these responsive coating surfaces are switched by electric field, thus one can conveniently and remotely control the switch to clean contaminates on the panels.

Fig. 2 Illustration of mechanically sliding down sand particles by switchable surface topographies in liquid crystal film.

METHODS

The coating is based on liquid crystal network (LCN) with a fingerprint texture. The LCN is made of dielectric liquid crystal mesogens. The chiral nematic liquid crystals are coated on the Interdigitated Electrode (IDE) substrate with vertical aligned polyimide boundary to form the fingerprint texture.

Fig. 3 (a) Monomers and photoinitiator for LCN polymer coating. (b) POM image of LCN fingerprint pattern. (c) Fingerprint LCN coating on the interdigitated electrodes array.

The IDE generates an in-plane AC electric field between the electrodes. The dielectric mesogens in LCN experience torque in the electric field, which can induce oscillation of mesogens in high frequency AC electric field.

Fig. 4 (a) Schematic illustration of the molecular order reduction induced volume increase and anisotropic deformations. (b) Planar domains and homeotropic domains exhibit different deformation behaviors.

RESULTS

When electric field is switched on:

- Oscillation of dielectric mesogens in high frequency AC electric field results in order parameter reduction.
- The decrease of order parameter causes planar domains to go up and homeotropic domains to go down, inducing inversion of the surface topography.

Fig 5. 3D view of fingerprint surface topography with electric field (a) On and (b) Off. (c) 2D profile of surface topography with electric field on/off, indicating inversion of the surface topography.

Fig 6. Application of the electrically switchable surface topography in dry self-cleaning. At electric field switching on/off moment, sand slide off due to the switched surface topography.

CONCLUSIONS

Our novel design of the smart surface, based on fingerprint liquid crystal network shows substantial and reversible changes of surface topography in response to the electric field, showing potentials in dry self-cleaning application.

REFERENCES

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