Colloidal gold nanosphere dispersions in smectic liquid crystals and thin nanoparticle-decorated smectic films

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(Received 11 November 2009; accepted 27 January 2010; published online 24 March 2010)

We demonstrate that the layer structure and elasticity stabilize dispersions of colloidal nanoparticles in smectic liquid crystals. We use surface plasmon resonance spectra of gold nanospheres to probe their spatial distributions in the bulk of smectic lamellae. The average interparticle distances between the well-separated nanoinclusions in thin (<100 nm) smectic films are probed by atomic force microscopy. We show that limited motion of nanoparticles across layers due to the one-dimensional quasi-long-range solid-like structure and their elasticity-mediated interactions preclude irreversible aggregation and enhance the stability of the ensuing nanoscale dispersions in thermotropic smectic liquid crystals. © *2010 American Institute of Physics*.
[doi:10.1063/1.3330678]

I. INTRODUCTION

Dispersions of colloidal particles in anisotropic liquid crystalline media are interesting from both fundamental physics and technological applications standpoints. Studies of colloidal microparticles in nematic[1–5] and smectic[6–11] liquid crystals (LCs) reveal strongly anisotropic long-range interactions that can be of both attractive and repulsive nature.[2] The interactions depend on topological defects and *director* structures occurring around the particles and are mediated by orientational elasticity of the surrounding LC medium. In the case of micron-sized inclusions embe-9 (R5nclusion2(nclusion1)-322.998clusion2(LC,8(nature11.64259.842fectcle)-36ar.842fec1s)-270.42fecn

(Φ) of GNPs, the suspension of the PVP coated GNPs in ethyl alcohol was mixed with the LC in the smectic A phase and the mixture was continuously stirred for about 5 h. For the optical absorption studies most of the ethyl alcohol was evaporated and the mixture filled into cells made of rubbed glass plates with thin polyimide alignment coatings. The remaining alcohol was allowed to evaporate over a few hours. Well-aligned smectic A samples with the *director* along the rubbing direction were obtained. The absorption spectra in the smectic A phase (at C) were obta ned us n t e Ocean Opt cs n ature ber opt c spectro eter (B) nte rated w t a po ar z n croscope O y pus BX (To yo Japan) For t e AFM stud es t e xture of t e coated GN s n et y a co o and LC w c was o o en zed by cont nuous st rr n for was sp n coated at revo ut ons per nute on a s con ( ) substrate T e sa p e surface orp o o y was stud ed us n nanoscope III AFM (fro D ta Instru ents) n t e tapp n ode To easure t e avera e t c ness of t e s ect c surface supported

t e surface pro e s ow t e defect nduced d p es n t e case of pure CB [F (f)] and t e ra sed bu ps due to part c e nduced ayer defor at ons n t e case of t e LC GN d spers ons [F ( )] nce t e s ect c A ater a s a D so d t at possesses a quas on ran e trans at ona or der n t e d rect on perpend cu ar to ayers t e surface or p o o y v sua zed by AFM re ects t e pro e of t e top s ect c ayer n t e t n T e apparent var at on n t e e t of nd v dua bu ps t be due to po yd spers ty of part c e s zes (trans ss on e ectron croscopy data s ow t at part c e d a eters vary fro to n w t an aver a e s ze of ~ n) for at on of d s ocat on oops of d f

sp ere d spers ons n sotrop c u ds t s of reat funda en ta nterest to exp ore t e feas b ty of ac ev n ordered per od c se f asse b y of nanopart c es and spat a struc tures co posed of nanopart c es and part c e e structures n a e ar LCs

IV. CONCLUSIONS

In conc us on we ave de onstrated t e en anced co o da stab ty of s ect c A LC nanopart c e d spers ons as co pared to t ose n ne at cs s n exper enta and co puter s u ated spectra we ave s own t at t e nterpart c e separat ons between so ated eta nanopart c es n t e bu of s ect c a e ae re a n ar e even for y concentrated suspens ons Nanopart c es n t n s a so do not a o erate but rat er od fy t e free surface pro e of t e due to ayer d stort ons around t e nc us ons n t e LC bu T e nanosca e d spers ons are of nterest for tec no o es t at requ re co pos tes cons st n of nanopart c es and a d e ectr c atr x w t tunab e propert es and nterpar t c e d stances w c ay prov de eans of spat a structur