Influence of chemical surface modifications on the nematic phase of rod-like viruses

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Many rod-like biological objects, such as DNA, F-actin, microtube and *fd* virus can form liquid-crystalline phase and have attracted intensive interests. In order to study the microstructure of the liquid crystal phase formed by these particles and the dynamics of single particles in such mesophase, a common strategy is to label some of the particles with fluorescence molecules as the probe and disperse the probe in the background of the unlabeled one. Then a wide range of techniques can be used to monitor the behavior of this probe and to extract information of the bulk system.[1] An implicit assumption is that the labeled particle has identical properties compared to the unlabeled one. In this contribution, we shall demonstrate that this is not the case. Several kinds of organic molecular compounds of different size and structure, including two popular fluorescence dyes, were labeled to *fd* viruses, a highly monodisperse rod-like particle which can form chiral nematic phase. Investigation on these labeled viruses reveals that the microstructure of the cholesteric phase shows some subtle difference compared with wild type *fd*. Depending on the structure of the labeled molecule, unwinding of the cholesteric pitch occurs. In one extreme case, surface charge of *fd* virus has been reversed from negative to positive, and the resulting particles only form a nematic phase. In addition, a thermo-sensitive polymer, poly(*N*-isopropyl acrylamide) (PNIPAM) was also grafted to the surface of *fd* virus. Besides gelling reversibly upon heating/cooling,[2] the polymer-virus hybrid particle can form nematic or cholesteric phase depending on concentration or ionic strength. This is in contrast to the system of *fd* grafted with a neutral polymer-poly(ethene glycol),[3] which has been shown to only form a cholesteric phase. These results indicate that such chemical modifications as dye labeling might change the surface properties,

rigidity of the virus and therefore the interactions between the labeled and the unlabeled particles.

References

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