Theoretical characterization of the surface free energy of a nematic in contact with microstructured substrates

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Nematic liquid crystal in presence of microstructured grooved substrates may show frustration in the orientational order, leading to elastic deformations in the nematic director field and in some cases the nucleation of topological defects. As a consequence, there is a contribution to the excess surface free energy associated to these elastic deformations. In the 70s, Berreman introduced a way to estimate this contribution for shallow substrates and when the nematic texture does not present topological defects. This approximation is qualitatively correct for nematics in contact with smooth substrates and no topological defects in the texture, but it fails in presence of cusped substrates, such as the sawtoothed and the crenellated gratings. We introduce a generalization of the Berreman expression when the nematic texture shows disclination lines, and we will discuss the effect of this contribution in wetting transitions.