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Instability of Polymer Films by Complete Dispersion Forces¹ HEPING ZHAO, YONG JIAN WANG, OPHELIA K.C. TSUI, Institute of Nano Science and Technology and Physics Department, Hong Kong — Many recent experiments showed that some polymer film systems with film thickness, h, in the nanometer range are unstable and may rupture spontaneously upon heating by the spinodal mechanism. The very criterion for this instability is the system free energy, G(h), possessing a negative second derivative. In a polar liquid films with h ~ 10 nm, the van de Waals interactions (vdW) comprise a major contribution to G(h) $A/12\pi h^2$ (besides surface tension) for which the approximate form, G(h) \sim (where A is the Hamaker constant), neglecting retardation effects, has been widely adopted. In this work, we calculated the exact solution for the complete vdW interactions based on the theory of Dzyaloshinskii, Lifshitz and Pitaevskii for the four-layer system, air/polystyrene/SiO₂/Si. We found that even when the thickness of the polymer and the SiO_2 layer are only 5 nm, retardation effects produce significant modifications to G(h), contrary to conventional expectations.

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Yong Jian Wang Institute of Nano Science and Technology and Physics Department Hong Kong

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