Specific Heat and Dielectric Susceptibility of Ferroelectric Thin Films

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Abstract: In this paper, ferroelectric thin films, described by an ising model in a transverse field, have been studied under the mean-field approximation. We discuss a thin film composed of N-layer film of simple cubic symmetry with nearest-neighbor exchange in which the exchange strength and transverse field are assumed to be different from the bulk values in N_s surface layers, and we derive and illustrate expression for specific heat and susceptibility. In such films, the Curie temperature can shift to either lower or higher temperature compared with the corresponding bulk value. If the surface exchange strength is strong enough, there is still a phase transition to ferroelectricity even when the transverse field is larger than the bulk critical value. The bulk peak of the specific heat becomes a discontinuity at the film curie temperature. There is a rounded peak at the bulk curie temperature if the surface exchange strength is higher than the critical value.

The film susceptibility still diverges at the film Curie temperature, as does the bulk susceptibility, but its magnitude is reduced. Also there is a rounded peak at the bulk Curie temperature when the surface exchange strength exceeds the critical value. The bulk related character of the specific heat and susceptibility is less pronounced and the surface – related character is more pronounced when the film thickness is small, or the surface – layer number is large.