**Time Dependent Landau Ginzbug Devonshire Equation**

The TD-LGD equation is:

The right-hand side includes a functional derivative, which can be solved using the Euler-Lagrange equation. Application of Euler-Lagrange to an integral functional gives:

When applied to the free energy functional, we arrive at:

Typically, we assume an isotropic gradient energy:

**Numerical Solution**

To solve the partial differential equations, we employ the semi-implicit Fourier spectral method. We 2D Fourier transform in the and directions. As discussed earlier, in the Fourier transform, differentiation becomes multiplication. Fourier transforms in and automatically impose periodic boundary conditions along and . We use a finite difference in the direction with boundary conditions . We consider the gradient terms in explicitly. is the second derivative of the 2D FFT of polarization with respect to . We consider the gradient terms in and implicitly. Let us 2D FFT both sides of the differential equation…

The second order finite difference approximation is:

for

We approximate the layer with the following:

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To ensure that the polarization is zero within the air and substrate, the landau term is dependent on z. Very large a1 in air and film (a0). Also all constants (G,q,etc…) are zero in air and substrate.

for