Multilayered ferromagnetic-polymer composite structures for integrated, high-density power supply inductors

Develop and demonstrate multilayered ferromagnetic-polymer composites as cores for miniaturized and integrated power inductors with:

- Inductance density: 100-1000 nH/mm²
- Current-handling: 0.5-1A
- Operation frequency: 1-10 MHz

### Magnetic Core - Targets

<table>
<thead>
<tr>
<th>Property</th>
<th>Target</th>
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</thead>
<tbody>
<tr>
<td>Permeability (a@10MHz)</td>
<td>&gt;250</td>
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<tr>
<td>Coercivity</td>
<td>&lt;5 Oe</td>
</tr>
<tr>
<td>Core thickness</td>
<td>50-100 microns</td>
</tr>
<tr>
<td>Saturation Magnetization</td>
<td>0.5-1 Tesla</td>
</tr>
</tbody>
</table>

### Prior Art

- Multilayered composite film (thickness~50 microns)
- Excellent permeability and Q-factors obtained with composite structure for frequencies of 1-10 MHz

### Proposed approach

- High μ at desired frequency due to thin magnetic layer
  (Layer thickness ~ skin depth)
- Multilayer film-stacking using ultra-thin polymer dielectric layers as adhesives to maintain high μa to ultra-thin film factor $\mu_a = qM_a$
- Pattern multilayer film and form coils around it to fabricate ultra-thin inductor structures

### Fabrication and characterisation of multilayered composite

- Cross-section analysis shows multilayered composite structure with ultra-thin polymer of thickness: 0.2-0.5 microns

### Modeling approach

Electromagnetic (EM) simulation of shorted strip-line structures using SONNET to extract frequency dependent permeability

### Summary

The proposed research describes a novel multilayered metal-polymer composite with high permeability and saturation magnetization at desired frequencies and a approach to integrate composite structure in inductor devices.