**Motivation**

The electric dipole moment (EDM) changes its sign as time is reversed. This is directly related to CP-violation. The CP-violation present in the standard model is insufficient to explain the abundance of matter and the lack of antimatter in the universe.

The SNS nEDM collaboration aims to measure the electric dipole moment of the neutron to a precision of $10^{-24} \text{e cm}$ by measuring the Larmor precession of the neutron in a magnetic field modulated by a reversing electric field. An essential requirement for this measurement is precision magnetic fields to guide the spins of polarized neutrons.

A critical requirement for this measurement is the neutron to a precision of $10^{-10}$.

**Abstract:** We are developing a prototype spin transport magnet for the SNS nEDM experiment. The coil is designed by solving a numerical boundary value problem of the magnetic scalar potential and fabricated by CNC photolithography using a 6-axis industrial robot.

**STEP 1: Substrate**

The 3-d coil surface substrate is fabricated using stereolithography (SLA) using a high-temperature ABS-like resin. This method is quick, less prone to human error, with feature detail of 0.1 mm. We ordered two printed pairs from stratasys.com and quickparts.com. Both were within specified tolerance.

**STEP 2: Copper Plating**

0.125 mm of copper using electroless electroplating at epner.com

**STEP 3: Etching**

Photolithography is widely used for device fabrication such as integrated circuits and thin film patterning. Ultra-violet (UV) laser light is used to sensitize a photoresist mask for etching. One of the benefits of this method is its non-destructive patterning: before etching, we can verify our traces. Another benefit is the precession and fine detail (100 micron).

A) Positive type photoresist is coated on the electroplate surface using a spray coating.

B) A UV laser attached to the robot traces the desired lines, sensitizing the photoresist. It is removed with a developer solution.

C) Exposed copper is etched with ferric chloride.

**Coil design of winding pattern**

This project is to demonstrate practical CNC construction techniques for surface current coils. The prototype is a tapered double cos-theta coil with a transverse field which decreases axially down the cylinder. The coil is constructed of two half-cylinder clam shells which clamp together around the He transport tube.

The equipotential contours were obtained by numerically a Laplace potential and fabricated by CNC fabricated using stereolithography (SLA) using a high-temperature ABS-like resin. This method is quick, less prone to human error, with feature detail of 0.1 mm. We ordered two printed pairs from stratasys.com and quickparts.com. Both were within specified tolerance.

**Photolithography Fabrication of a Clamshell Surface Current Coil for the nEDM Experiment**

**Robot control software for etching of the circuit traces.**

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