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Methods for TEMPO-doping Araldite Epoxy

Abstract

Araldite Epoxy doped with TEMPO has been found to be a suitable target material for dynamic nuclear polarization. Maximum proton polarization value of 13.8 percent has been achieved with a magnetic field of 4.998 T and a temperature of about 1.2 K. The simple process of preparing a TEMPO-doped target makes it an attractive option for DNP.

1 Background/Motivation

TEMPO-doped Araldite epoxy targets are attractive to DNP groups for their production properties. The targets are free form, quickly reproducible and relatively harmless in production. With simple machining of a teflon block you can create any shape for a target.

2 Safety

Personal protective equipment while handling TEMPO.

1. Safety Mask
2. Lab Coat
3. Gloves
4. Eye Protection [Goggles]

All TEMPO related activities must be performed under the fume hood.

3 Purpose

This note is a generalized procedure for creating TEMPO-doped epoxy targets.

3.1 List of Materials

In the following, we describe a list of materials needed to make a TEMPO-doped epoxy target.

List of Materials:

1. TEMPO
2. Rapid (5min) Aralidte Epoxy
3. Magnet Wire
4. Teflon (Polytetrafluoroethylene) Block
5. Teflon (Polytetrafluoroethylene) Sheet

3.2 Procedure

In the following, we describe the procedure.

Procedure:

1. Prepare a Teflon mold suitable for your target cup. On one side of the mold create a channel large enough such that a coiled wire may pass through.
2. Prepare a magnet wire coil such that its first loop is as large as possible while not in contact with any sides of the mold. Remaining wire must be coiled such that it fits through the channel prepared earlier.
3. Place teflon mold on teflon sheet inside fume hood.
4. Place magnet wire coil inside the mold such that it is horizontal and suspended in the center of the mold. Cover the remainder of the channel so epoxy does not run out.
5. Proper safety equipment must be worn from this point on.
6. Thoroughly mix TEMPO and Resin. 1 part TEMPO for 100 part Resin. Place resin onto paper plate or any disposable surface, place TEMPO into resin and stir thoroughly for 20sec or until TEMPO is uniformly distributed throughout the resin. Do not attempt to mix in plastic bag, this will led to an uneven mixture.

   ex.) 1mg TEMPO with 1g Resin. The Alpha target used in the Dec 2018 cooldown consisted of 6.98g Resin, 0.07-0.10g TEMPO, and 6.84g Hardener. [Inaccuracy in TEMPO due to scale fluctuations]
7. Thoroughly mix TEMPO-Resin with Hardener. Amount of Hardener must equal the amount of Resin added in previous part. 1 part Resin with 1 part Hardener

   ex.) 1.001g TEMPO-Resin with 1g Hardener

8. Pour TEMPO epoxy paste into teflon mold such that the coil is completely covered.
9. Let sit in fume hood until TEMPO epoxy fully cures.
10. Remove TEMPO epoxy from mold. Clean excess from epoxy block so that it fits into target cup.
11. Safely store TEMPO epoxy target and clean fume hood, teflon block, and teflon sheet.

References

[1] Yohei Noda, 'Thermosetting polymer for dynamic nuclear polarization: Solidification of an epoxy resin mixture including TEMPO',Nuclear Instruments and Methods in Physics Research, 9 Dec 2014.

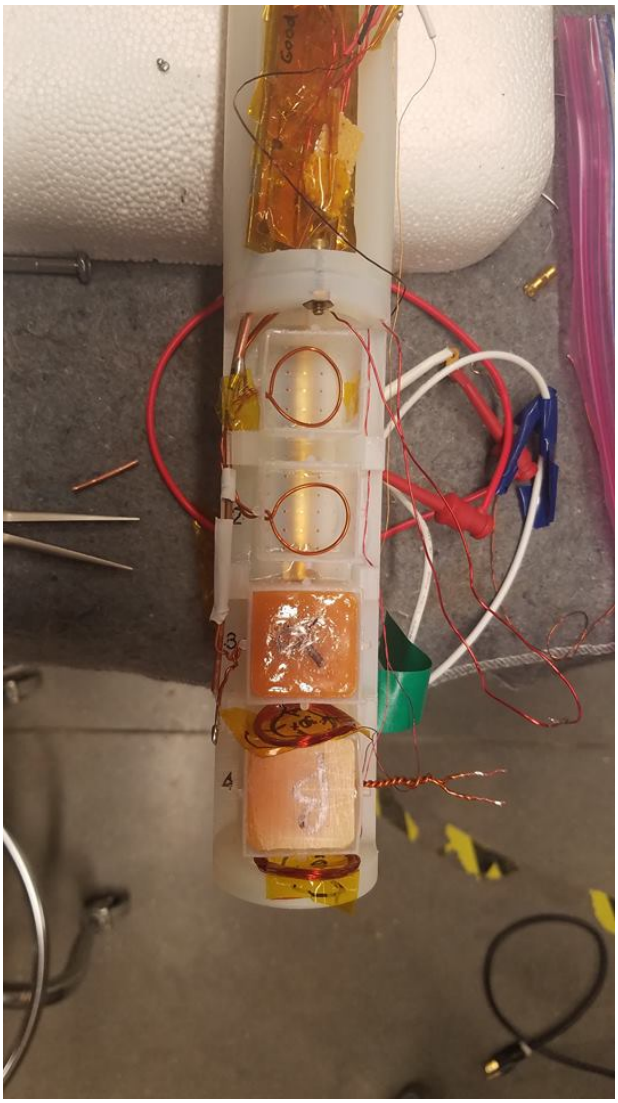

Figure 1: Target Stick with Alpha and Beta TEMPO Epoxy Targets