# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Or S. Weizman

**Project Number**
**S0522**

**Project Title**
## Synthesis and Characterization of a Self-Healing Polymer

**Abstract**

**Objectives/Goals**
Polymers are very useful materials that are used in many applications, but over time they undergo wear and tear. An appealing solution to this problem is the creation of self-healing polymers, polymers that have the ability or mechanism to self-repair cracks that form in them. The objective of this project is to synthesize building blocks for a new polymer that is cross-linked by Diels-Alder bonds. The reversibility of the Diels-Alder reaction allows the polymer to be repeatedly mended under mild heating condition. The design of the new polymer is based on cross-linking between maleimide and furan groups. The new monomer has a different symmetry from previous works, which makes it less flexible and is made by fewer synthetic steps. The new design will create an easy to synthesize monomer that can be polymerized to give a polymer that regains its resistance to fracture.

**Methods/Materials**
New molecules were synthesized using organic chemistry techniques. The reactions were set under inert conditions (under argon) using dry solvents. The compounds were isolated by extractions and column chromatography. The structure of the molecules was then confirmed by Nuclear Magnetic Resonance and Mass Spectrometry. The monomers were polymerized under different conditions followed by Differential Scanning Calorimetery to study the formation and behavior of the polymer.

**Results**
I was able to successfully synthesize two monomers. Nuclear Magnetic Resonance and Mass Spectrometry confirmed that the desired monomers are indeed the molecules that were designed. The monomers were polymerized under various conditions to form stable polymers. Differential Scanning Calorimetery studies showed an increase in the melting temperature compared to previous polymers. While having higher melting point, the new monomer 3FT is synthesized in fewer steps and has a higher chemical stability at room temperature. Heating and quenching experiments demonstrated the reversibility of the Diels-Alder reaction that allows the polymer to be repeatedly mended under mild heating condition.

**Conclusions/Discussion**
Modifying the symmetry and flexibility of the furan building block resulted in more chemically stable monomers and thermally stable self-healing polymers

**Summary Statement**
New molecules were synthesized and polymerized to form a polymer that is capable of self-repairing cracks

**Help Received**
Worked at University of California San Diego under the supervision of Christian Nielson and Professor Nemat-Nasser