1. **Research Title:** Synthesis of Germanium-Containing Polymers
2. **Individual Sponsor:**
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3. **Academic Area/Field and Education Level:** Chemistry and Polymer Science & Engineering, Organic Polymer Synthesis and Thermomechanical Characterization (BS, MS, or PhD level)

4. **Objectives:** The objectives of this research topic are:
   - Synthesis of germanium-containing small molecules for use in anionic polymerization
   - Characterization of small molecules and polymers utilizing a variety of structural techniques.
   - Investigate polymerization conditions and understand the kinetic behavior and mechanism of polymerization in these new monomers.
   - Characterize the low temperature thermal behavior of the synthesized polymers
   - Characterization of the temperature-dependent mechanical properties of the synthesized polymers
   - Demonstrate additive manufacturing approaches to process polymers.
   - Demonstration of adhesive and/or sealant properties
   - Incorporation of new functionality in polymer backbone/side chain and demonstration of low temperature self-healing capabilities.

5. **Description:** Materials that can withstand the extreme environments such as the arctic and space, require resilient properties for longevity and survivability. For polymeric materials, one primary requirement is to maintain viscoelastic properties at extremely low temperatures (<-100 °C). As such, the exploration of new materials beyond polyolefins, perfluoronated hydrocarbons, and pure siloxane-based scaffolds is critical and necessitates the development of new and less understood chemistries. Noting the chemistry inherent to polysiloxanes has enabled low-temperature polymer development, we seek to explore polymers derived from other group 14 elements (*e.g.*, polygermanoxanes & polystannoxanes). While the most recent efforts focus on caged structures from these novel organometallics, linear polymers and copolymers with the ability to exert control over the polymerization (*i.e.*, living polymerizations) are desired as well as the synthesis of functional monomers for polymerization to generate a library of new materials prime for classic polymer chemistry investigations for low temperature applications. Other polymer behavior may be inherent to these structures including stimuli-responsiveness and self-healing capabilities that have thus far gone unstudied and will be of interest to the broader DAF community.

6. **Research Classification/Restrictions:** Ability to obtain clearance for the DAF (must be a U.S. citizen)

7. **Eligible Research Institutions:** Open to all Ohio-based academic institutions

8. **PA Approval #: e.g.** AFRL-2024-3084