RQ 18-34

1. **Research Title:** Magnetocaloric effect of Ni-Mn based Heusler alloys
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:** Materials Science and Engineering, Applied Physics, and Mechanical Engineering (MS or PhD level)

4. **Objectives:** Tailor magneto-structural phase transition temperatures and increase entropy change of Ni-Mn based Heusler alloys.

5. **Description:** An increasing emphasis on vehicle electrical power and related technologies requires not only efficient generation, conversion/conditioning of high electrical power but also efficient management of thermal loads associated with it. Magnetic refrigeration, based on the magnetocaloric effect, offers 60 percent Carnot efficiency which is ~ 15 percent higher than that of vapor cycle systems. Their robust design (less moving parts, only solid to solid change of state) also makes them attractive. Among several material systems, Ni-Mn based Heusler alloys have attracted a lot of attention recently due to their giant magnetocaloric effect and refrigerant capacity. These properties are the results of the presence of a first order magneto-structural phase transition between austenite and martensite as well as due to structural and compositional disorder, especially in off-stoichiometric alloys of Ni-Mn-X (X = Ga, Al, Sn, In, Sb). We are interested in tailoring magneto-structural phase transition temperatures and increasing entropy change (connected directly to the magnetocaloric effect) of these alloys by compositional modifications and interstitial doping. In order to control the level of disorder related to a maximum magnetocaloric effect, different cooling rates and homogenization heat treatments (e.g., annealing time) can be applied to the alloys. A large magnetic entropy change has to be explained from the point of view of the atomic order, thermal strain and sub-grain microstructure and has to be related to magnetic and thermal properties of the alloys based on the following measurements: magnetization, permeability, hysteresis, heat capacity, and thermal conductivity. This project involves research from the fundamental magnetic materials level to the device level.

6. **Research Classification/Restrictions:** This research is anticipated to be fundamental in nature, with no inherent publication or presentation restrictions.

7. **Eligible Research Institutions:** All DAGSI

Public Release Approval Pending