Title: Preparation and characterization of nano-sized NiO powders and thin films;

Funding agency: CSIR, New Delhi

Prof. Perumal Alagarsamy - Department of Physics

The primary idea is to prepare nanosized NiO powders and NiO based nanocomposites by mechanical alloying process using planetary ball mill technique and magnetron sputtering techniques, respectively. Study their suitability in various applications, such as energy harvesting from biomechanical activities from daily-life to power up low-power electronics like a wristwatch, LEDs and harvest biomechanical energy from the stomach expanding (inhale and exhale) during standing, sitting, and bending positions.

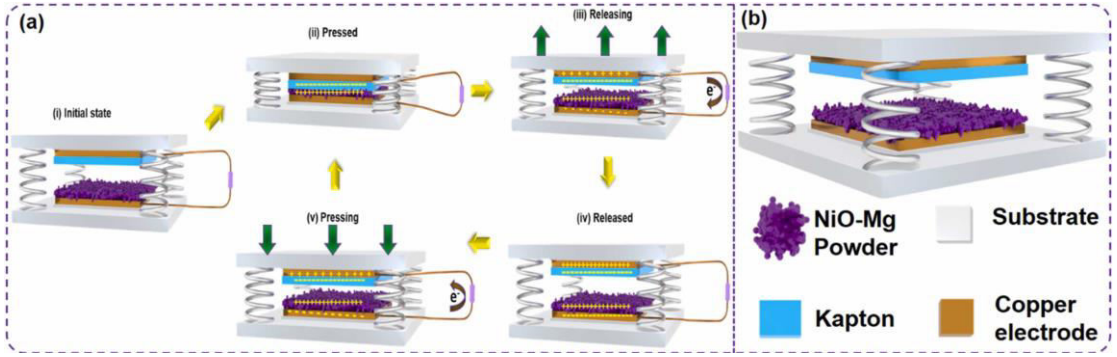
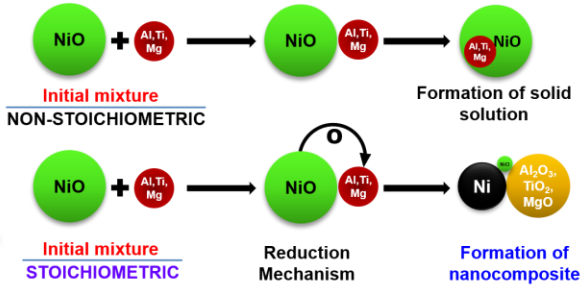


Figure: (a) Working mechanism of the TENG device in vertical contact-separation mode; (b) Layer-by-layer arrangement of the TENG device structure.

Highlights / Achievements:

- NiO-(Al,Ti,Mg) as-mixed powders produces nanocomposites of NiO-Ni-(Al_2O_3, TiO_2, MgO) through thermodynamically preferred solid-state reduction reaction.
- The magnetic properties are strongly dependent on the content of the Al, Ti, and Mg added to NiO, which change the type of the MC reduction reaction from a gradual one to a self-propagated combustion type.
- These ferromagnetic nanocomposites are currently used for energy harvesting from biomechanical activities, as shown in the pictures.



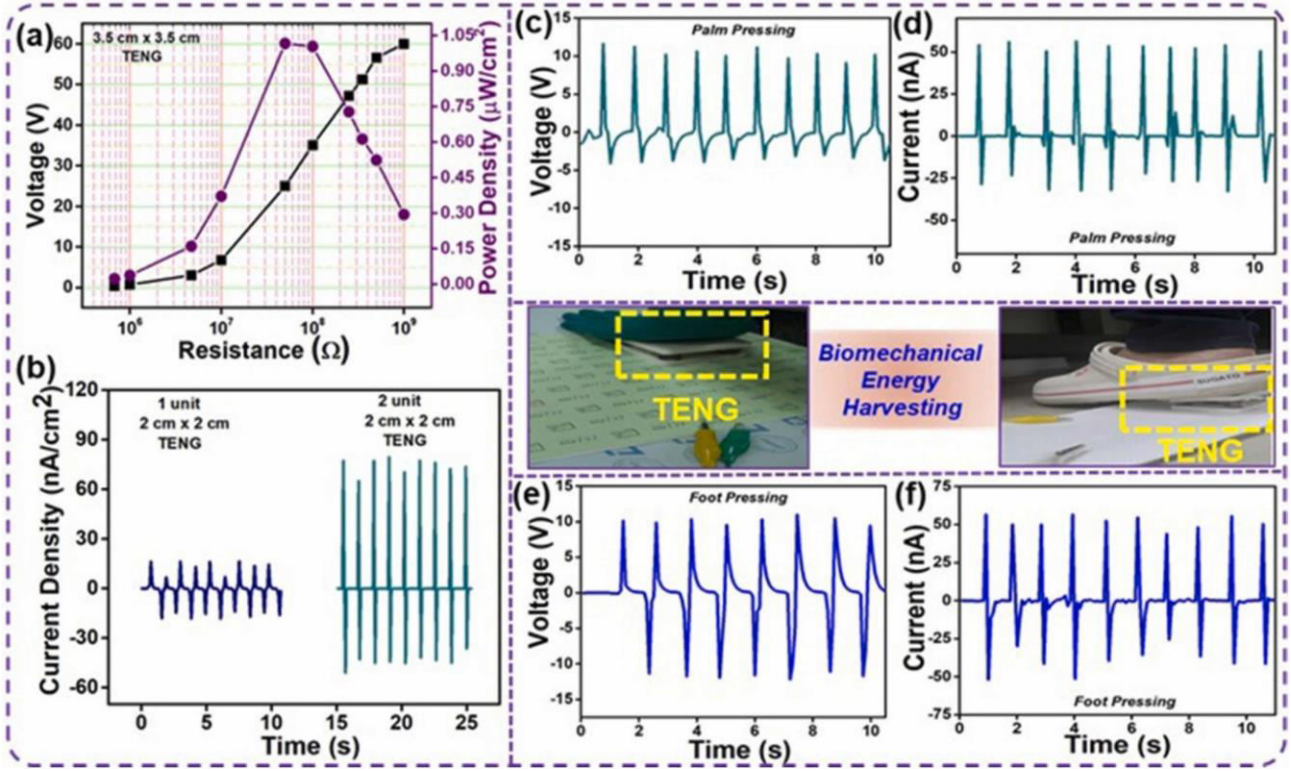


Figure: (a) Power density versus load resistance analysis for TENG having the active area of 3.5 cm × 3.5 cm; (b) current density comparison between single and two units of TENGs having an active area as 2 cm × 2 cm; electrical voltage and current responses of the single unit TENG device (2 cm × 2 cm) during the palm pressing (c, d) and foot pressing (e, f).

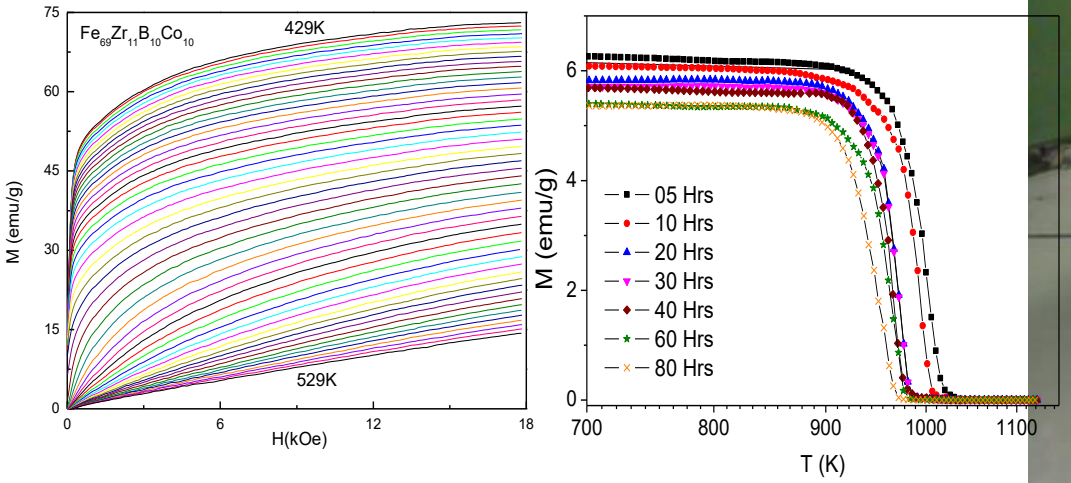
Title: Investigations of magnetic properties of selected novel magnetic materials

Funding agency: DST, New Delhi

Prof(s). A. Srinivasan, S. Ravi, Perumal Alagarsamy, P. K. Iyer - Department of Physics / Chemistry

The primary idea of the project is to set up Electromagnet based Vibrating Sample Magnetometer (VSM) facility and to study the magnetic properties of selected novel magnetic materials as a function of temperature from 20 K to 1270 K and as a function of field from 0 – 3 Tesla.

One of the state of the art facilities, set up in the North Eastern region. The procured facility is the "work horse" for the research group working on magnetic materials.



Data taken using VSM (left) and Photoview of the VSM installed in the department of Physics (right)

Title: Laminated magnetic thin films for soft magnetic applications

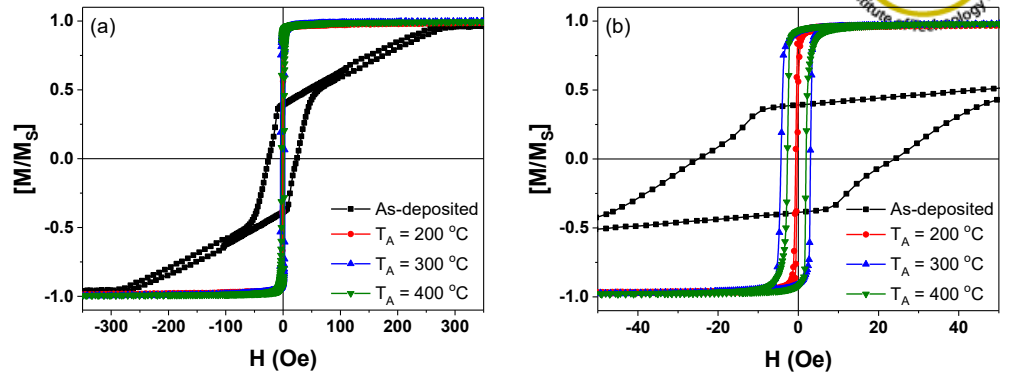
Funding agency: BRNS, Mumbai

Prof. Perumal Alagarsamy - Department of Physics

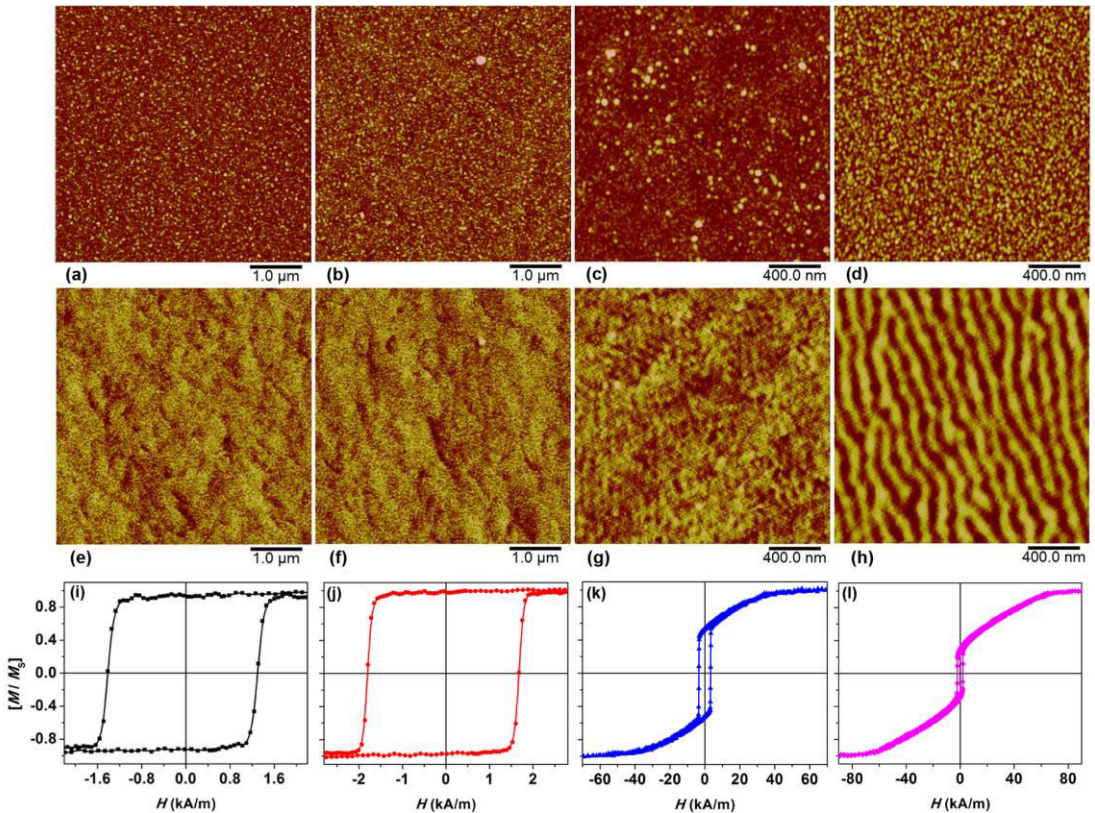
The major motivation is to fabricate and optimize the growth conditions of single-layer and multi-layer films of $Fe_{80}Ta_8C_{12}$ (FeTaC) and $Fe_{70}Co_{15}Zr_7B_5Cu_3$ (FeCoZrBCu) to obtain soft magnetic properties in higher thickness films (>100 nm) using laminated structures for the applications in spintronics devices.

Highlights / Achievements:

- Demonstrated markedly the effect of film thickness on the spin reorientation transition from in-plane domain to stripe domain patterns with perpendicular anisotropy in amorphous magnetic thin films.
- Executed turning of the stripe domain patterns with perpendicular anisotropy observed at higher thickness films into in-plane magnetic domains with soft magnetic properties at higher film thicknesses using laminated type structures.
- Understanding the magnetic interactions between the ferromagnetic films in laminated thin films and their individual and/or collective magnetic reversal phenomena at different low measurement temperatures.
- Angle dependent domain image analysis revealed unusual contribution of transverse component of magnetization in the magnetization reversal process in laminated thin films.



Room temperature *M-H* loops measured along the film plane for FeTaC (200 nm) film annealed at different temperatures.



Atomic Force Microscopy and Magnetic Force Microscopy images and room temperature *M-H* loops for FeTaC (*t* nm) films with (a,e,i) *t* = 20 (b,f,j) *t* = 30, (c,g,k) *t* = 50, (d,h,l) *t* = 100.