Conclusions

The present work was carried out to study the influence of various processing parameters such as annealing temperature, holding time and cooling rate under hydrogen atmosphere on the structural, magnetic and electrical characteristics of the Ni-Fe alloys. The prepared samples were characterised for industrial applications such as watch and audio recording applications and then compared the performance of the material/device developed through the proposed route with the existing.

The materials were characterised for their chemical composition by wet chemical analysis and atomic absorption spectrometer. The ring samples were prepared using a specially designed die and punch. The samples were annealed in the hydrogen atmosphere through indigenously designed annealing furnace. The phase analysis, microstructural characterization and magnetic measurements were carried out by XRD, optical microscope and B-H analyser respectively. The AC magnetic properties such as induction, remanence, coercivity, peak permeability and core loss were studied as a function of frequency, field strength, annealing temperature, cooling rate and holding time. Another heat treatment process was carried out in an atmosphere of cracked ammonia.

Detailed preparation and characterization of permalloy materials was carried out in this work. Based on the experimentation carried out, we conclude that

- The magnetic properties such as remanence, coercivity, peak permeability and core loss are highly structure sensitive and show changes with change in the process parameters.
- The magnetic properties of the permalloys show strong dependence to its crystal structure and annealing conditions. We found that grain diameter and ordering parameter have significant effect on the magnetic properties of the alloys.
- Out of three Ni-Fe based permalloys 82.13 % Ni (sample A), 79.90 % Ni (sample B) and 47.01 % Ni (sample C), 82.13 % Ni alloy is found to show better magnetic properties over the other two alloys as a function of different process parameters. We attribute it to relatively larger grain diameter (320 μm) and short-range order developed in 82.13 % Ni alloy over others two alloys.

- The 79.90 % Ni permalloys shows better and improved magnetic properties at lower frequency and at lower field strength indicates their better use at these parameters.
- The magnetic properties of the high Ni (Ni ~ 82 %) alloy are better in comparison to low Ni (Ni ~ 47 %) alloy at lower frequency i.e. 100 Hz.
- It was also found that there is not any significant change in the magnetic properties of permalloys annealed under two different environment conditions (H_2, Cracked ammonia).
- The watch movement was tested for its electro-mechanical characteristics such as current consumption and torque. We found that for watch movement, in 79.90 % Ni alloy, the resistance of the coil core can be increased from 2.30 kΩ (existing) to 3.20 kΩ by maintaining the acceptable limit of torque but in 47.01 % Ni alloy, the resistance of coil core can be increased only upto 2.80 kΩ and the battery life of the watch movement has been improved by 38% using 79.90 % Ni alloy over 47.01 % Ni alloy.
- The permalloys in the audio head was tested for its audio recording characteristics such as hum noise, sensitivity and frequency response. We found that 82.13 % Ni alloy is having better audio recording characteristics over the 79.90 % Ni alloy due to the better magnetic properties of 82.13 % Ni alloy.

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