

# International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI)

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## New soft magnetic steel alternate to Si-steel

### Overview

Soft magnetic steel forms an essential component in all motors and alternators used in the automotive industry. Currently for high efficient motors Si steel (typical Si content ~2%) is being used. The ever increasing demand to phase out fossil fuel automobiles and move to electric driven vehicles requires high performance motors. Hence there is a focus on alternate soft magnetic material which is cost effective and with better magnetic properties compared to Si steel. In this background we propose Fe-P as a potential alternate which is cost effective and with magnetic properties equivalent/better than Si steel. Fe-P based alloy prepared by wrought metallurgy process of induction melting, forging, hot rolling and subjected to a suitable two step heat treatment process yield soft magnetic materials with properties equivalent or better than Si steel. The formation of fine nano-precipitates of Fe<sub>3</sub>P enhances the resistivity of the alloy lowering the core loss at high frequency. Currently we have developed alloys with coercivity less than 1 Oe and a core loss of 187 W/kg at 1 kHz measured at B<sub>max</sub> 1 T

### Key Features

- Industrially viable wrought metallurgy process
- Alloy produced from low cost raw materials (cost effectiveness)
- Better mechanical properties advantages of machinability
- Good magnetic properties equivalent/better than commercial materials



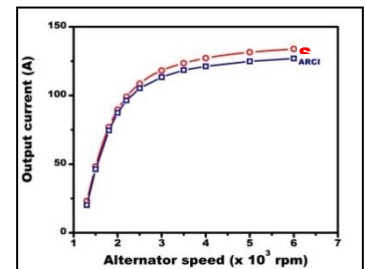
The claw pole rotor made using Fe-P alloy developed at ARCI and the prototype alternator using the rotor

### Potential Applications

- Used in alternators of automobiles
- Used in manufacture of various motors used in automobiles
- Explored for applications involving magnetic switching in valves and switch gears.

### Intellectual Property Development Indices (IPDI)

- Magnetic properties measured and benchmarked with standard commercial materials
- Prototypes produced and being benchmarked with commercially used machines



Comparison of the prototype alternator with the commercial standard alternator showing matching performance

Status	1	2	3	4	5	6	7	8	9	10
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### Major Publications

- 1) Effect of Si addition on AC and DC magnetic properties of (Fe-P)-Si alloy, *AIP Advances* 6, 055921 (2016)
- 2) AC magnetic properties and core loss behaviour of FeP soft magnetic sheets, *IEEE Transactions on Magnetism* 50 (2014) 2008604
- 3) High saturation magnetization in Fe-0.4 wt.% P alloy processed by a two-step heat treatment *Journal of Magnetism and Magnetic Materials* 345 (2013) 239.

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