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Study of radiation effect and magnetic field on Ni-Cr alloy properties

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ABSTRACT

An experimental investigation of applying a magnetic field and a radiation source horizontally with the direction of alloy once and vertically in another, current range passing through alloy is (1-3) AMP. The increase in temperature will lead to reduce electrical conductivity. The increase in input power causes an increase in output power. The increasing in magnetic field intensity will increase alloy efficiency. The increase in radiation time will increase alloy efficiency. The increase in magnetic field intensity in the presence of radiation will increase the alloy efficiency.

Introduction

Martensitic transformations are extensively influenced by external fields, such as temperature and uniaxial stress. They modify transformation temperature, crystallography and amount of the product marten sites. Therefore, to investigate the effect of external fields on martensitic transformation is very important to understand the basic problems of the transformation, such as thermodynamics, kinetics and origin of the transformation. Magnetic field and hydrostatic pressure are also such external fields because some differences in magnetic moment and atomic volume exist between parent and martensitic phases [Kim, 2006].

Magnetic field is one of the important external physical quantities which affect properties of materials and has been the subject of interest and research for more than a century not only in pure physics but also in materials science. Especially, recent development of the instruments producing extremely high magnetic fields seems to give us completely new means to explore various properties in materials [Kajiwara,1997].

The use of alloys by humans started with the use of meteoric iron, a naturally occurring alloy of nickel and iron. As no metallurgic processes were used to separate iron from nickel, the alloy was used as it was [Rickard, 1941]. http://en.wikipedia.org/wiki/Alloy - cite_note-5

Many ancient civilizations alloyed metals for purely aesthetic purposes. In ancient Egypt and Mycenae, gold was often alloyed with copper to produce red-gold, or iron to produce a bright burgundy-gold. Silver was often found alloyed with gold. These metals were also used to strengthen each other, for more practical purposes. Quite often, precious metals were alloyed with less valuable substances as a means to deceive buyers [Paul, 2000].

Alloys are often made in order to alter the mechanical properties of the base metal, to induce hardness, toughness, ductility, or other desired properties. While most metals and alloys can be work hardened by inducing defects in their crystal structure, caused by plastic deformation, some alloys can also have their properties altered by heat treatment. Nearly all metals can be softened by annealing, which repairs the crystal defects, but not as many can be hardened by controlled heating and cooling. Many alloys of aluminum, copper, magnesium, titanium, and nickel can be strengthened to some degree by some method of heat treatment, but few respond to this to the same degree that steel does[Jon,2006].

Experimental Part

The material that used in this work is $Ni^{70\%}$-$Cr^{30\%}$ alloy wired as coil of 10cm length and three coils. The resistivity was measured using Keithly electrometer.

The electrical conductivity σ_v was calculated by:

$$\sigma_v = \frac{1}{\rho_v} = \frac{L}{RA} \qquad (1)$$

Where:

A = cross-sectional area (cm^2)

R = volume resistance (Ohm).

L = wire length (cm).

The source of radiation was Beta with activity of 4.5μCi, current range passing through alloy is (1-3) AMP. A digital thermometer was used as temperature measurement.

Results and Discussions

Results were obtained for the effect of radiation and magnetic field on Ni-Cr alloy properties, it is noted from fig.(1) that the increase in temperature will lead to reduce electrical conductivity, due to that the magnetic field was in opposite direction with the flow of free electrons, that is lead to increase resistance(increase temperature) which lead to reduce the electrical conductivity.

Fig.(2) is the same of the case in fig.(1) except replacing magnetic field by radiation, the radiation will be in opposite direction with free electrons , lead to increase resistance(increase temperature) which lead to reduce the electrical conductivity. Fig.(3) is collecting the two cases in fig.(1) and fig.(2).

Fig.(4) is the same case in fig.(1) but the magnetic field was in horizontal with respect to alloy. The decreases in electrical conductivity was due to the obstruction of the electrons in the alloy.

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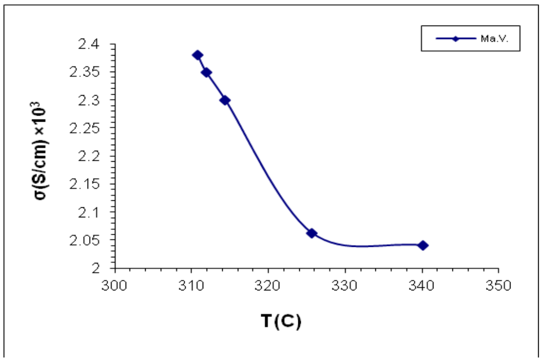
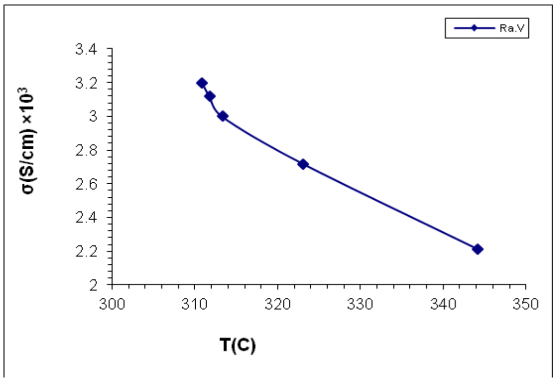
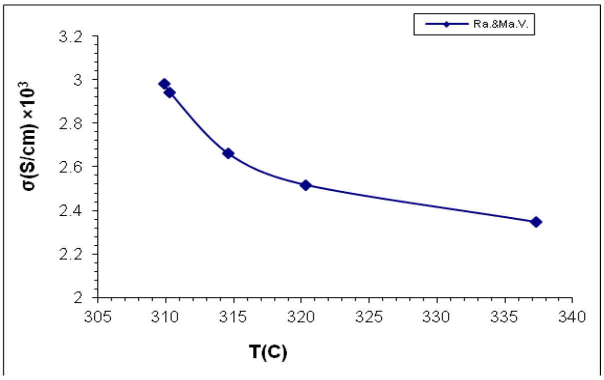


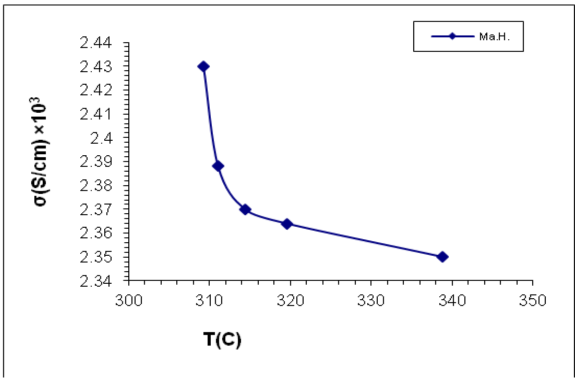
Fig(1)Effect of Temperature on electrical conductivity of Ni-Cr alloy in the presence of magnetic field in vertical direction



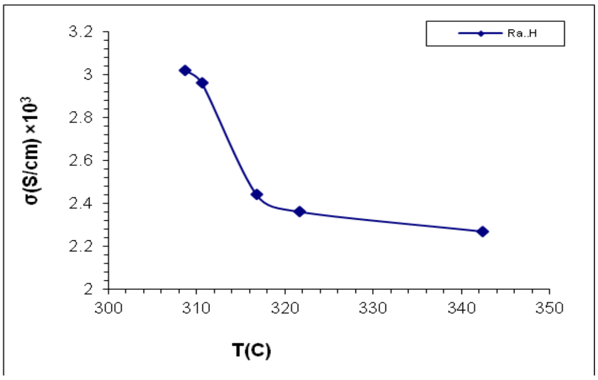
Fig(2) Effect of Temperature on electrical conductivity of Ni-Cr alloy in the presence of radiation in vertical direction



Fig(3) Effect of Temperature on electrical conductivity of Ni-Cr alloy in the presence of magnetic field and radiation in vertical direction

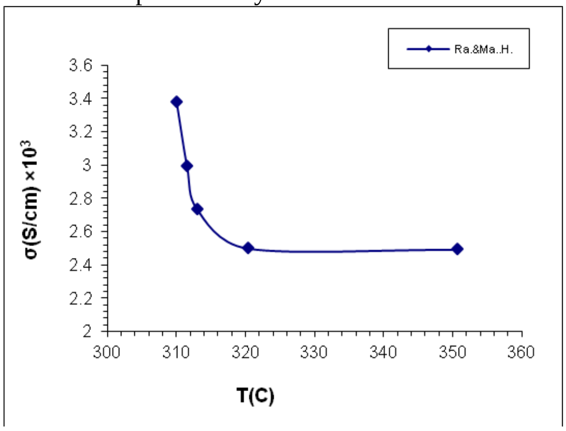


Fig(4) Effect of Temperature on electrical conductivity of Ni-Cr alloy in the presence of magnetic field in horizontal direction



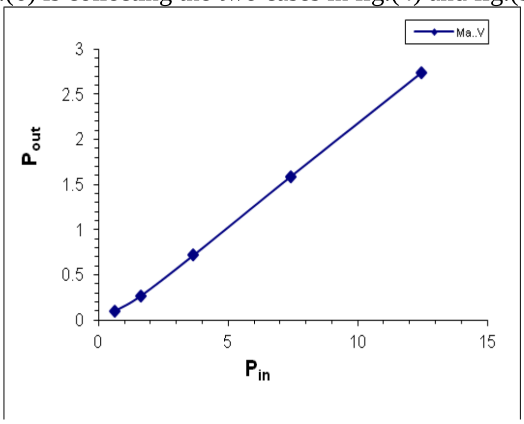
Fig(5) Effect of Temperature on electrical conductivity of Ni-Cr alloy in the presence of radiation in horizontal direction

Fig.(5) is the same case in fig.(2) but the radiation was in horizontal with respect to alloy.



Fig(6) Effect of Temperature on electrical conductivity of Ni-Cr alloy in the presence of magnetic field and radiation in horizontal direction

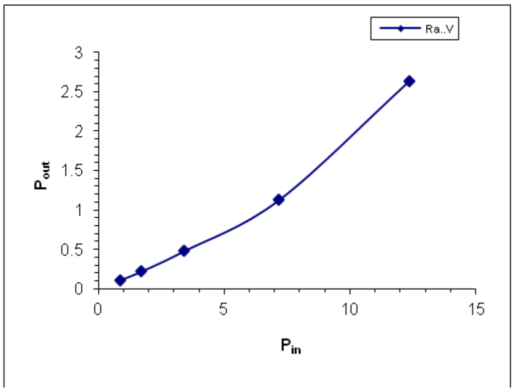
Fig.(6) is collecting the two cases in fig.(4) and fig.(5).



Fig(7) Variation of output power with input power of Ni-Cr alloy in the presence of magnetic field in vertical direction

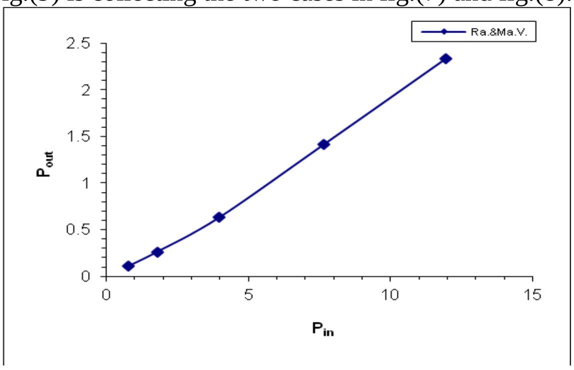
Fig.(7) represents the variation of output power with input power of Ni-Cr alloy in the presence of magnetic field in vertical direction, the increase in input power cause an increase in output power, the magnetic field direction in line with the flow of free electrons.

Fig.(8) is the same as in the case in fig.(7) except replacing magnetic field by radiation.



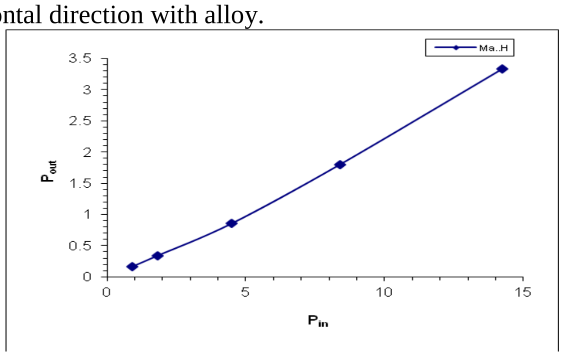
Fig(8) Variation of output power with input power of Ni-Cr alloy in the presence of radiation in vertical direction

Fig.(9) is collecting the two cases in fig.(7) and fig.(8).



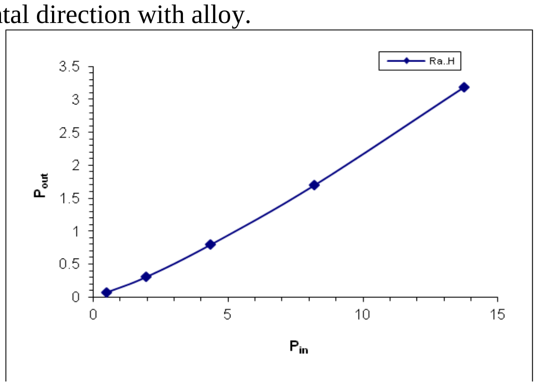
Fig(9) Variation of output power with input power of Ni-Cr alloy in the presence of magnetic field and radiation in vertical direction

Fig.(10) is the same case in fig.(7) but the magnetic field in horizontal direction with alloy.



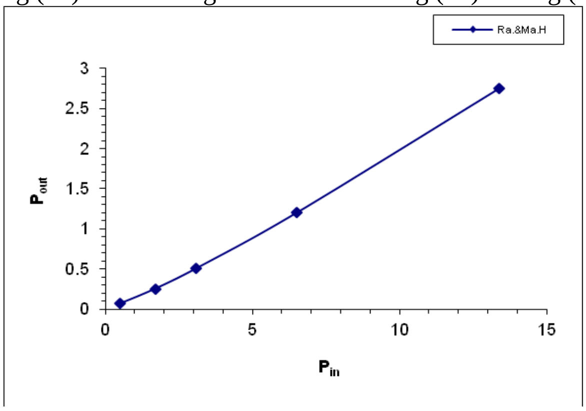
Fig(10) Variation of output power with input power of Ni-Cr alloy in the presence of magnetic field in horizontal direction

Fig.(11)) is the same case in fig.(8) but the radiation in horizontal direction with alloy.



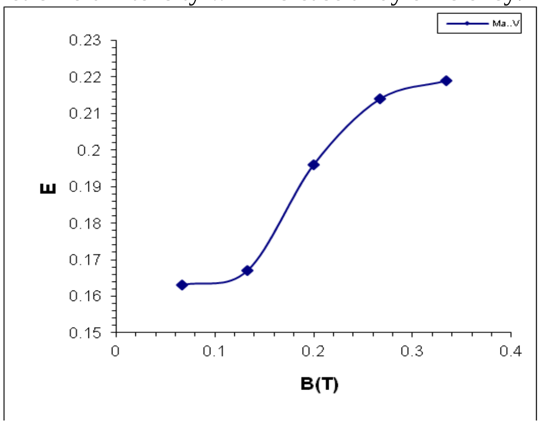
Fig(11) Variation of output power with input power of Ni-Cr alloy in the presence of radiation in horizontal direction

Fig.(12) is collecting the two cases in fig.(10) and fig.(11).



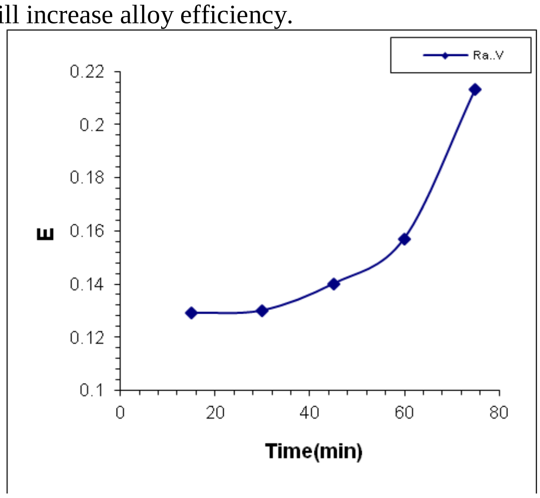
Fig(12) Variation of output power with input power of Ni-Cr alloy in the presence of magnetic field and radiation in horizontal direction

Fig.(13) represents the variation of efficiency of Ni-Cr alloy with magnetic field intensity in vertical direction, the increasing in magnetic field intensity will increase alloy efficiency.



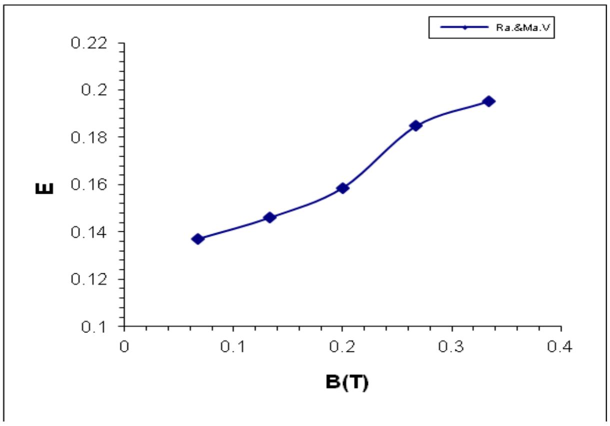
Fig(13) Variation of efficiency of Ni-Cr alloy with magnetic field intensity in vertical direction

Fig.(14) represents the variation of efficiency of Ni-Cr alloy with radiation time in vertical direction, the increase in radiation time will increase alloy efficiency.



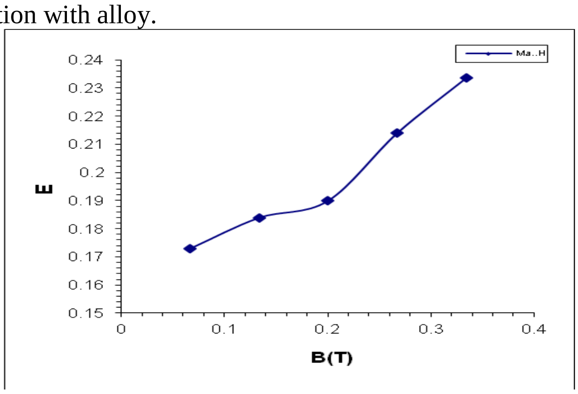
Fig(14) Variation of efficiency of Ni-Cr alloy with radiation time in vertical direction

Fig.(15) represents the variation of efficiency of Ni-Cr alloy with magnetic field intensity in vertical direction in the presence of radiation, the increase in magnetic field intensity in the presence of radiation will increase the alloy efficiency.



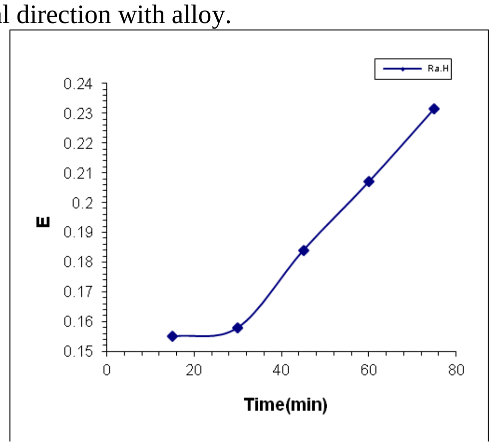
Fig(15) Variation of efficiency of Ni-Cr alloy with magnetic field intensity in vertical direction in the presence of radiation

Fig.(16) is the same case in fig.(13) but in horizontal direction with alloy.



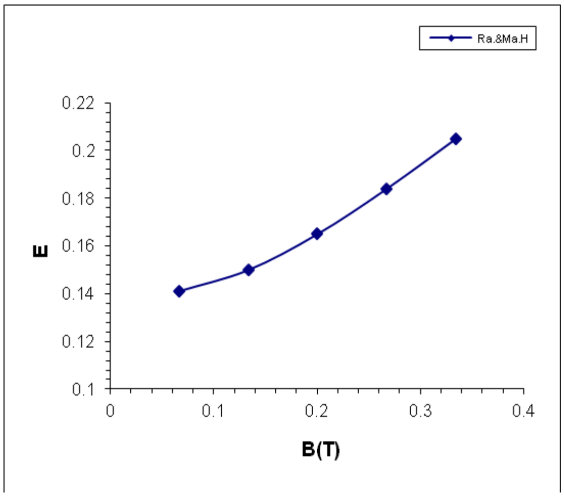
Fig(16) Variation of efficiency of Ni-Cr alloy with magnetic field intensity in horizontal direction

Fig.(17) is the same case in fig.(14) but the radiation in horizontal direction with alloy.



Fig(17) Variation of efficiency of Ni-Cr alloy with radiation time in horizontal direction

Fig.(18) is collecting the two cases in fig.(16) and fig.(17).



Fig(18) Variation of efficiency of Ni-Cr alloy with magnetic field intensity in horizontal direction in the presence of radiation

Conclusions

The following conclusions were obtained from this research:

1. The increase in temperature will lead to reduce electrical conductivity.
2. The increase in input power causes an increase in output power.
3. The increasing in magnetic field intensity will increase alloy efficiency.
4. The increase in radiation time will increase alloy efficiency.
5. The increase in magnetic field intensity in the presence of radiation will increase the alloy efficiency.

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