Coupled investigations: analytic solutions of forces, characters, and responses for the phenomena for elements in materials science

Mohammad Rangga Yudha Kusumah

Abstract: This article explains coupled investigations leading to analytic solutions of forces, characters, and responses for the phenomena for elements by investigating forces, characters, and responses equations as differential equations. Various interactions of elements create matters in this world. Configuration, bonds, and composition of elements changes create from various interactions of matters. Various interactions of matters reveal from various natural evidences or various experimental implementations. Tendencies of elements of being stables inspire from responseless boundaries and elements sequences. Various configurations, bonds, and compositions of elements define matters in this world. Matters as functions of elements and their responseless boundaries create from various materials characters differences.

Keywords: forces, characters, and responses, differential equations, elements, matters, configurations, bonds, compositions, responseless boundaries, and elements sequences.

1. Matter as Elements Collection

Material is divided into cells containing elements of the electrons, atoms, grains, microstructures, macrostructures, or bulks [2]. Cells evolve using either stochastic or deterministic dynamics [2]. Electrons, atoms, grains, microstructures, macrostructures, or bulks of the material are elements of matter. Atoms of the material can have elements of the protons, neutrons, and electrons of the atoms. Grains, clusters, or phases of the material can include elements of the atoms of the grains, clusters, or phases. Microstructures of the material correspond with elements of the grains, clusters, and phases of the microstructures. Macrostructures of the material deal with elements of the microstructures of the macrostructures. Bulks of the material integration can incorporate elements of the composites, metals, ceramics, or polymers of the bulks that incorporation scoup is more and more big.

2. Matter to Analytic Solutions of Force, Character, and Response

The matter is a differentially analytic solution elemental that determines the all electronical, atomical, microstructural, macrostructural, or structural material within responseless boundary at elements sequences. A unit phenomenological electronical, atomical, microstructural, macrostructural or structural material determines the matter. Thus, the matter is electronical, atomical, microstructural, macrostructural, or structural material dependent elemental. It can change to material and focuses on phenomenologically changeable elemental.

The force, character, and response of matter are differentially analytic solutions phenomenological that determines the differential equation for elements within responseless boundary at elements sequences. A unit phenomenological differential equation determines the force, character, and response equation for elements. Thus, force, character, and response of matter are differential equation dependent phenomenological. They can change to differential equation and focus on phenomenologically changeable phenomenological.

3. Analytic Solutions of Force, Character, and Response for the Phenomenon for Elements

Analytic solutions of force, character, and response depend on the all interactions of elements of matters, the abilities of elements to create elements motions from matter to matter, and the elements motions from matter to matter for elements. There are various analytic solutions of forces, characters, and responses for the phenomena for elements. Several analytic solutions of forces, characters, and responses for the phenomena for elements have been reported in literature [1]. Concentration curvature, diffusion coefficient, and concentration rate are analytic solutions of force, character, and response for the diffusion for bulks. Temperature

- *Mohammad Rangga Yudha Kusumah is a materials reliability specialist, currently developing stress-strength reliability models of fatigue, yield, fracture, rupture, and combined failures for Gas Cylinder, pipe, pressure vessel, and heat exchanger. E-mail: ranggayudha80@yahoo.com* curvature, thermal diffusivity, and temperature rate are analytic solutions of force, character, and response for the heat transfer for bulks. Newton uses force, mass, and acceleration of force, character, and response for the motion for bulks. Analytic solutions of force, character, and response for the electric current for electrons are electric potentials gradient, electric resistance, and electric current. Application of Faradays's models focuses on analytic solutions of electric dipole, magnetic permeability, and magnetic induction for the interaction of electric and magnetic for electrons. Analytic solutions are solved by replacing force, character, and response with measurements stages. Coupled investigation serves to verify the analytic solutions of force, character, and response and confirms the interpretation of the phenomenon equation for elements.

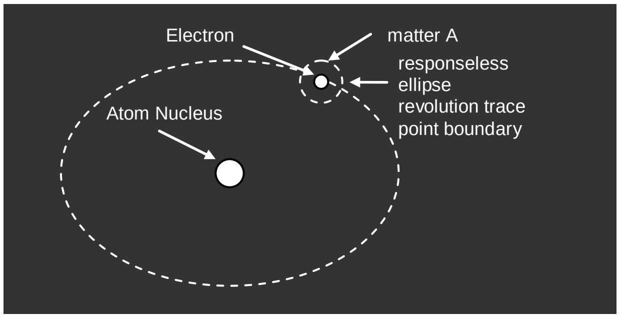

Fig.1. Electron is stable in matter A and move to another matter A

Matter A (fig.1) or B (fig.2) response occurrence is often phenomenologically based on electron motion from matter A or B to another matter A or B and responseless ellipse revolution trace point boundary or responseless ellipse revolution trace boundary change as long as the electron and the responseless ellipse revolution trace point boundary or the responseless ellipse revolution trace boundary are a transportable electron and a changeable boundary. The matter A or B is a differentially analytic solution electronical that determines the each electron of hydrogen within responseless ellipse revolution trace point boundary or responseless ellipse revolution trace boundary at electron sequence.

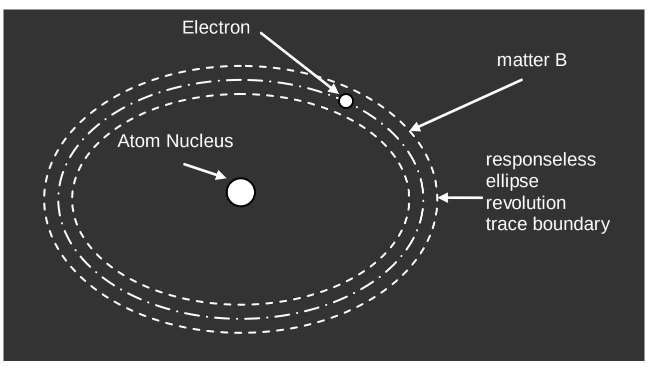

Fig.2. Electron is stable in matter B and move to another matter B.

Matters states gradient stage is way of specifying the all interactions of elements of matters. Force depends on the all interactions of elements of matters or the each interaction of matters. Matters states gradient stage is associated with force. At that moment, matter orderliness and disorderliness stage is way of specifying the all orderliness and the disorderliness of types of elements (composition), interactions of elements bonds (elements bonds), and elements bonds configuration (structure) for elements. Character depends on the all interactions of elements of matter or the all abilities of elements to create elements motions from matter to matter. Matter orderliness and disorderliness stage is associated with character. A unit phenomenological differential equation (1) determines the response (R) which is proportional to the force (F) of matter:

$$R \approx F \tag{1}$$

Where, response is dependent variable depending on force and character (F and C) which are independent variables. A unit phenomenological differential equation (2) determines the response (R) which is proportional to the force (F) multiplying the character (C) of matter:

$$R \approx F \cdot C \tag{2}$$

Where, force is driving force, character is motion ability, response is motion. The all elements motions from matter to matter (response) depend on the all interactions of elements of matters (force) multiplying the all abilities of elements to create elements motions from matter to matter (character).
Response (R) along with character (C) integration can determine energy of response of elements condition that determination scoup is more and more big. A unit phenomenological differential equation (3) determines the energy of response of elements (E) which is proportional to the character (C) dividing the response (R) square of matter:

$$E \approx \frac{R^2}{C} \tag{3}$$

In terms of resistance (r) as responseless ability, response (R) corresponding to zero is proportional to force resultant (F) corresponding to zero or resistance (r) corresponding to very large or to draw near to infinite value. A unit phenomenological differential equation (4) determines the energy of response of elements (E) which is proportional to the resistance (r) multiplying the response (R) square of matter:

$$E \approx r \cdot R^2 \tag{4}$$

4. Responseless Boundary

Matter boundary stage is way of stabilizing the all orderliness and the disorderliness of types of elements (composition), interactions of elements bonds (elements bonds), and elements bonds configuration (structure) and differentiating the all interactions of elements of matters with the all abilities of elements to create elements motions from matter to matter. Or, in another preception, matter boundary stage is way of avoiding the each element motion from matter to matter. Responseless boundary depends on the each element motion from matter to matter or response. Matter boundary stage is associated with responseless boundary. Thus, matter boundary stage is response dependent boundary. It can change to response and focuses on phenomenologically changeable boundary. But, it can't change to response if it focuses on phenomenologically unchangeable boundary or an infinite boundary. Thus, it focuses on phenomenologically unchangeable boundary.

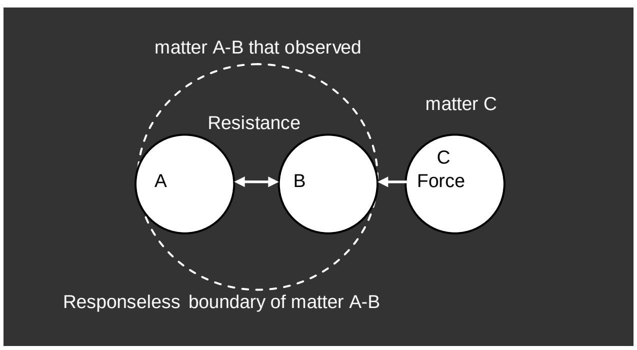

Fig.3. Responseless boundary of matter A-B

Figure 3 shows model for the each boundary of atoms A – B or the each boundary between atoms B – C which is a responseless boundary. Several measurements stages of responseless boundaries showed in figure 4 have been solved of matters A, B, and C boundaries stages.

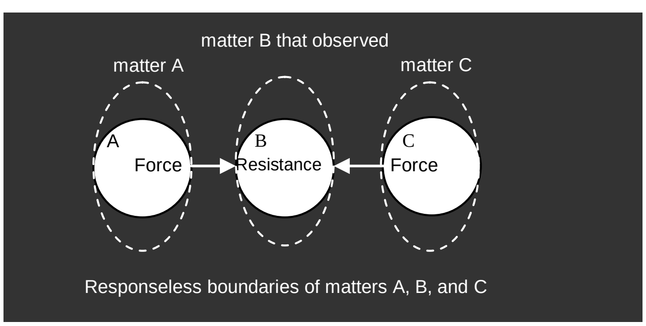

Fig.4. Responseless boundaries of matters A, B, and C

5. Imperfection

Analytic solution of character for the each disorderliness of types of elements (composition), interactions of elements bonds (elements bonds), and elements bonds configuration (structure) for elements is imperfection. Matter disorderliness stage is way of solving imperfection. Analytic solution of character for the each disorderliness for elements is imperfection.

Imperfection corresponding to 0 % depends on the each disorderliness corresponding to 0% (very perfect). Thus, response - alligning - to - force corresponding to 100 % is proportional to imperfection corresponding to 0 %. Imperfection corresponding to x % depends on the each disorderliness corresponding to x % (not very perfect). Therefore, response – aligning – to - force corresponding to (100 - x %) and deviating – to - character corresponding to (x %) is proportional to imperfection corresponding to x %. Units phenomenological differential equations determine the forces and responses of matter in the following examples as follow.

1. Mechanic load (Δforce / ΔF) shape,
2. Thermal (Δtemperature / ΔT) shape,
3. Optic (ΔWave Length / Frequency) / (Δλ / Δf)) shape,
4. Electric potential (Δvoltage / ΔV) shape,
5. Electrochemical potential (ΔElectrochemical Force / ΔEMF) shape,
6. Magnetic (ΔElectromagnetic Force / Δμ) shape

can have force that at their principles to give delta or difference to matter in order that matter responds to be in accord with their parable stage. For examples;

1. Atom responded of;
1. the mechanic vibration (low response) or
2.the deformation alteration (high response) corresponds with mechanic load (Δforce / ΔF) shape.

2. Atom and electro n responded of the heat transfer (molecule kinetics) in:
1. the rotation, vibration (low response)
2. the translation / diffusion (high response) corresponds with thermal (Δtemperature / ΔT) shape.

3. Atom and electron responded of its wave of reflection as:
1. the wave character based on wave frequency or length response
2. the wave intensity based on absorption and transmittion response corresponds with optic (ΔWave Length / Frequency) / (Δλ / Δf)) shape.

4. Electron and atom responded of
1. the current alteration (low response)

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2.the thermal and heat (high response) corresponds with electric potential gradient (Δvoltage / ΔV) shape.

5. Electron and atom responded of the oxidation reaction corresponds with electrochemical potential gradient (ΔElectrochemical Force / ΔEMF) shape.

6. Atom and electron responded of:
1. the electron spin (thiny response)
2.the domain wall (thick response) corresponds with magnetic (ΔElectromagnetic Force / Δμ) shape.

Two examinations results examples with their forces and responses are the followings.

1. Mechanic load result at tension examination:

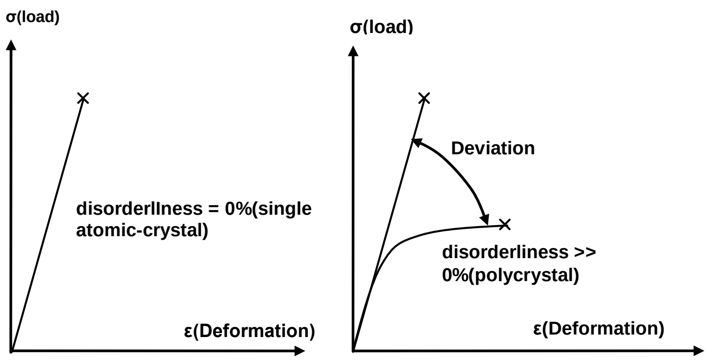


Fig.5. the tension exam result graphic that shows the deviation occurrence due to the disorderliness

2. X – ray examination result at solid metal:

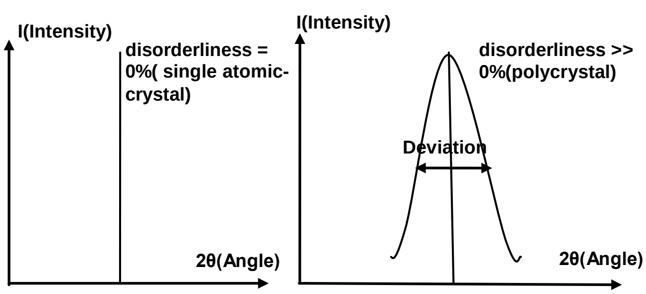


Fig.6. the x – ray exam result graphic that shows the deviation occurrence due to the disorderliness.

Units phenomenological differential equations determine the forces, characters, and responses equations for the phenomena in the following examples as follow.

6. General Analytic Solutions of Forces, Characters, and Responses

Several measurements stages of forces, characters, and responses equations have been solved of matters states gradient, matter orderliness and disorderliness, and matter motions frequencies stages which are ways of specifying the all interactions of elements of matters, the abilities of elements to create elements motions from matter to matter, and the elements motions from matter to matter functions. Forces, characters, and responses equations are differential equations for the phemonena functions for elements. Investigations on forces, characters, and responses equations at elements sequences help to approximate what the phemonena functions will occur to matter that investigations scoup are more and more big. A moment after the matter interacts with another matter, forces, characters, and responses equations become the phemonena functions at elements sequences.

7. Analytic Solutions of Temperature Curvature, Thermal Diffusivity, and Temperature Rate

Analytic solutions of force, character, and response for the all interactions of atoms of nickel-environment, the abilities of atoms to create atoms vibrations, rotations, and translations from nickel to environment, and the atoms vibrations, rotations, and translations from nickel to environment for atoms are temperature curvature, thermal diffusivity, and temperature rate. Nickel-environment temperatures gradient, nickel temperature cross sectional area per time, and nickel atoms vibrations, rotations, and translations frequencies stages are ways of solving temperature curvature, thermal diffusivity, and temperature rate. Temperature curvature, thermal diffusivity, and temperature rate are analytic solutions of force, character, and response for the heat transfer for atoms. Coupled investigation serves to verify the analytic solutions of force, character, and response and confirms the interpretation of the heat transfer equation for atoms.

Analytic solution of force for the all interactions of atoms of nickel-environment (pattern 1) or the interactions of atoms of environment-nickel (pattern 2) is temperature curvature (figure 7). Several measurements stages of temperature curvatures have been solved of nickel-environment and environment-nickel temperatures gradient stages.

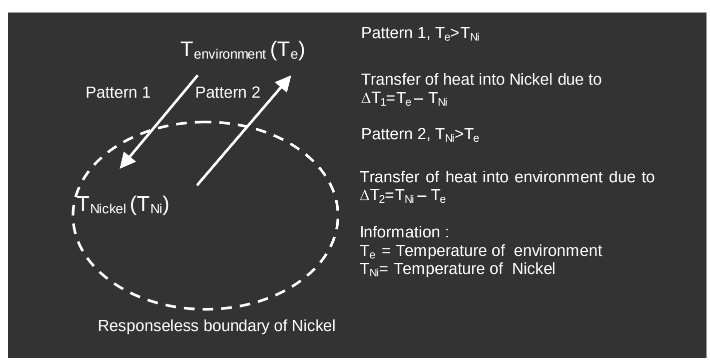


Fig.7. Heat transfer on Nickel

Thus, the thermal diffusivity is a differentially analytic solution character that determines the all abilities of atoms to create atoms vibrations, rotations, and translations from nickel to environment at atoms sequences. Since the atoms vibrations, rotations, and translations from nickel to environment exist the interactions of elements of matters and the abilities of atoms to create atoms vibrations, rotations, and translations from nickel to environment exist. A unit phenomenological differential equation (5) determines the thermal diffusivity (α_{th}) which is proportional to inverse of the temperature rate (∂T / ∂t) of nickel:

$$\alpha_{th} \approx f^{-1}\left(\frac{\partial T}{\partial t}\right) \tag{5}$$

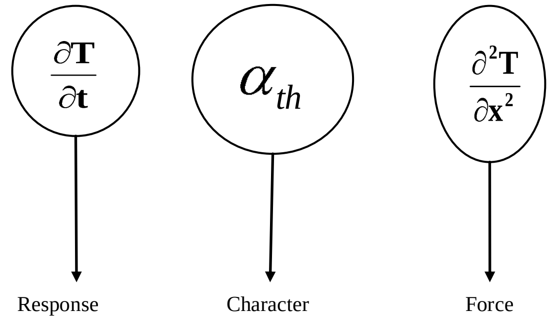
Furthermore, the temperature rate is a differentially analytic solution response that determines the all atoms vibrations, rotations, and translations from nickel to environment at atoms sequences. The atoms vibrations, rotations, and translations from nickel to environment are proportional to the interactions of elements of matters and the abilities of atoms to create atoms vibrations, rotations, and translations from nickel to environment. A unit phenomenological differential equation (6) determines the temperature rate (∂T / ∂t) which is proportional to the temperature curvature ($\partial^2 T$ / ∂x^2) and the thermal diffusivity (α_{th}) of nickel:

$$\frac{\partial T}{\partial t} \approx f\left(\frac{\partial^2 T}{\partial x^2}, \alpha_{th}\right) \tag{6}$$

Temperature curvature - thermal diffusivity - temperature rate for the heat transfer corresponding to first Fick's law analytic solutions of force, character, and response for the heat transfer,

$$\frac{\partial T}{\partial t} = \alpha_{th}\frac{\partial^2 T}{\partial x^2} \tag{7}$$

are proportional to analytic solutions of force, character, and response corresponding to as follow:



8. Analytic Solutions of Concentration Curvature, Diffusion Coefficient, and Concentration Rate

Steel-environment carbons concentrations gradient, steel carbons concentration cross sectional area per time, and steel carbons interstisial translations frequencies stages are measurements of concentration curvature, diffusion coefficient, and concentration rate for the all interactions of carbons of steel-environment, the abilities of carbons to create carbons interstisial translations from steel to environment, and the carbons interstisial translations from steel to environment. Steel-environment carbons concentrations gradient, steel carbons concentration cross sectional area per time, and steel carbons interstisial translations frequencies stages are ways of solving concentration curvature, diffusion coefficient, and concentration rate. Concentration curvature, diffusion coefficient, and concentration rate are analytic solutions of force, character, and response for the diffusion for carbons. Coupled investigation serves to verify the analytic solutions of force, character, and response and confirms the interpretation of the diffusion equation for carbons.

Therefore, the diffusion coefficient is a differentially analytic solution character that determines the all abilities of carbons to create carbons interstisial translations from steel to environment at carbons sequences. Since the carbons interstisial translations from steel to environment exist, the interactions of carbons of steel-environment and the abilities of carbons to create carbons interstisial translations from steel to environment exist. A unit phenomenological differential equation (8) determines the diffusion coefficient (D) which is proportional to inverse of the concentration rate (∂C / ∂t) of steel:

$$D \approx f^{-1}\left(\frac{\partial C}{\partial t}\right) \tag{8}$$

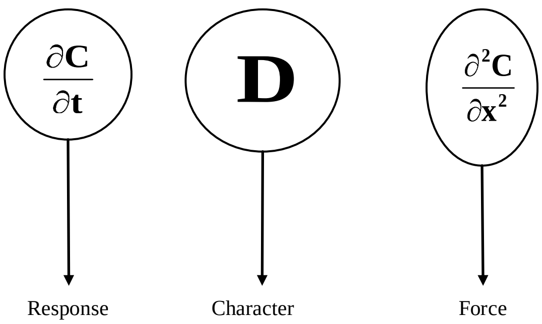
Furthermore, the concentration rate is a differentially analytic solution response that determines the all carbons interstisial translations from steel to environment at carbons sequences. The carbons interstisial translations from steel to environment are proportional to the interactions of carbons of steel-environment and the abilities of carbons to create carbons interstisial translations from steel to environment. A unit phenomenological differential equation (9) determines the temperature rate (∂C / ∂t) which is proportional to the concentration curvature ($\partial^2 C$ / ∂x^2) and the diffusion coefficient (D) of steel:

$$\frac{\partial C}{\partial t} \approx f\left(\frac{\partial^2 C}{\partial x^2}, D\right) \tag{9}$$

Concentration curvature - diffusion coefficient - concentration rate corresponding to second Fick's law analytic solutions of force, character, and response for the mass transfer,

$$\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial x^2} \tag{10}$$

are proportional to analytic solutions of force, character, and response corresponding to as follow:



9. Analytic Solutions of Temperatures Gradient, Linear Coefficient of Thermal Expansion, and Thermal Expansion

Measurements of temperatures gradient, linear coefficient of thermal expansion, and thermal expansion are aluminium-environment temperatures gradient, aluminium strain per temperature, and aluminium inter – atoms distance translations frequencies stages of force, character, and response for the all interactions of atoms of aluminium-environment, the abilities of atoms to create atoms inter – atoms distance translations from aluminium to environment, and the atoms inter – atoms distance translations from aluminium to environment. Aluminium-environment temperatures gradient, aluminium strain per temperature, and aluminium inter – atoms distance translations frequencies stages are ways of solving temperatures gradient, linear coefficient of thermal expansion, and thermal expansion. Temperatures gradient, linear coefficient of thermal expansion, and thermal expansion are analytic solutions of force, character, and response for the thermal expansion for atoms. Coupled investigation serves to verify analytic solutions of force, character, and response for the thermal expansion and confirms the interpretation of the thermal expansion equation for atoms.

For that matter, the linear coefficient of thermal expansion is a differentially analytic solution character that determines the all abilities of atoms to create atoms inter – atoms distance translations from aluminium to environment at atoms sequences. Since the atoms inter – atoms distance translations from aluminium to environment exist the interactions of atoms of aluminium-environment and the abilities of atoms to create atoms inter – atoms distance translations from aluminium to environment exist. A unit phenomenological differential equation (11) determines the linear coefficient of thermal expansion (α_L) which is proportional to inverse of the thermal expansion (∂l / l_0) of aluminium:

$$\alpha_L \approx f^{-1}\left(\frac{\partial l}{l_0}\right) \tag{11}$$

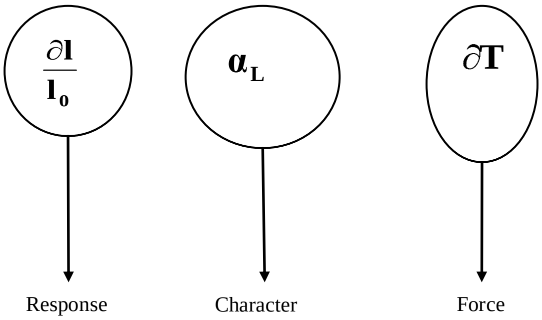
Furthermore, the thermal expansion is a differentially analytic solution response that determines the all atoms inter – atoms distance translations from aluminium to environment at atoms sequences. The atoms inter – atoms distance translations from aluminium to environment is proportional to the interactions of atoms of aluminium-environment and the abilities of atoms to create atoms inter – atoms distance translations from aluminium to environment. A unit phenomenological differential equation (12) determines the thermal expansion (∂l / l_0) which is proportional to the temperatures gradient (∂T) and the linear coefficient of thermal expansion (α_L) of aluminium:

$$\frac{\partial l}{l_0} \approx f(\partial T, \alpha_L) \tag{12}$$

Temperatures gradient - linear coefficient of thermal expansion - thermal expansion corresponding to inter – atoms distance translation analytic solutions of force, character, and response for the thermal expansion,

$$\frac{\partial l}{l_0} = \alpha_L \cdot \partial T \tag{13}$$

are proportional to analytic solutions of force, character, and response corresponding to as follow:



10. Analytic Solutions of Magnetic Fields Gradient, Magnetic Permeability, and Magnetic Induction

A set phenomenogical magnetical fields gradient, magnetical permeability, and magnetical induction solutions for the all interactions of electrons of iron-environment, the abilities of electrons to create electrons spins alterations from direction to direction, and the electrons spins alterations from direction to direction determine iron-environment magnetic fields gradient stage, iron magnetization per magnetic field stage, and iron spins alterations frequencies stage. Iron-environment magnetic fields gradient, iron magnetization per magnetic field, and iron spins alterations frequencies stages are ways of solving magnetic fields gradient, magnetic permeability, and magnetic induction. Magnetic fields gradient, magnetic permeability, and magnetic induction are analytic solutions of force, character, and response for the magnetic induction for electrons. Coupled investigation serves to verify analytic solutions of force, character, and response for the magnetic induction and confirms the interpretation of the magnetic induction equation for electrons.

The point was that, the magnetic permeability is a differentially analytic solution character that determines the all abilities of electrons to create electrons spins alterations from direction to direction at electrons sequences. Since the electrons spins alterations from direction to direction exist the interactions of electrons of iron-environment and the abilities of electrons to create electrons spins alterations from direction to direction exist. A unit phenomenological differential equation (14) determines the magnetic permeability (μ_0) which is proportional to inverse of the magnetic induction (B) of iron.

$$\mu_0 \approx f^{-1}\left(B\right) \tag{14}$$

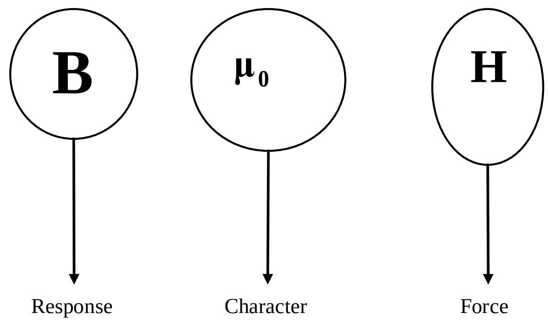
Furthermore, the magnetic induction is a differentially analytic solution response that determines the all electrons spins alterations from direction to direction at electrons sequences. The electrons spins alterations from direction to direction are proportional to the interactions of electrons of iron-environment and the abilities of electrons to create electrons spin alterations from direction to direction. A unit phenomenological differential equation (15) determines the magnetic induction (B) which is proportional to the magnetic fields gradient (H) and the magnetic permeability (μ_0) of iron.

$$B \approx f\left(H, \mu_0\right) \tag{15}$$

Magnetic fields gradient - magnetic permeability - magnetic induction corresponding to spins alterations analytic solutions of force, character, and response for the magnetic induction,

$$B = \mu_0 \cdot H \tag{16}$$

are proportional to analytic solutions of force, character, and response corresponding to as follow:



11. Analytic Solutions of Electric Potentials Gradient, Electric Resistance, and Electric Current

Application of copper-environment electric potentials gradient, copper resistivity per length, and copper charges transportations frequencies stages focuses on the all interactions of electrons of copper-environment, the abilities of electrons to resist charges transportations from copper to environment, and the charges transportations from copper to environment. Copper-environment electric potentials gradient, copper resistivity per length, and copper charges transportations frequencies stages are ways of solving electric potentials gradient, electric resistance, and electric current. Electric potentials gradient, electric resistance, and electric current are analytic solutions of force, character, and response for the charges transportations for electrons. Coupled investigation serves to verify analytic solutions of force, character, and response for the charges transportations and confirms the interpretation of the charges transportations equation for electrons.

Conductivity (σ) is also designed completely as copper charges number per length stage at that moment the copper is attempted to electric potentials gradient (ΔV) or driving force. Charges number presences and interaction of charges and atoms bonds, configuration, and composition differentiate the conductivity (σ). Copper can have many electrons of its conduction stage. A band gap for semiconductor is an extra energy to create semiconductor charges from valency stage to conduction stage. A band gap for ceramic is a very large extra energy to create ceramic charges from valency stage to conduction stage.

That fact proved that, the electric resistance is a differentially analytic solution character that determines the all abilities of electrons to resist charges transportations from copper to environment at charges sequences. Since the charges transportations from copper to environment exist, the interactions of electrons of copper-environment and the abilities of electrons to resist charges transportations from copper to environment exist. A unit phenomenological differential equation (17) determines the 1/electric resistance (1/R) which is proportional to inverse of the electric current (I) of copper:

$$\frac{1}{R} \approx f^{-1}(I) \tag{17}$$

Furthermore, the electric current is a differentially analytic solution response that determines the all charges transportations from copper to environment at charges sequences. The charges transportations from copper to environment are proportional to the interactions of electrons of copper-environment and inversely proportional to the abilities of electrons to resist charges transportations from copper to environment. A unit phenomenological differential equation (18) determines the electric current (I) which is proportional to the electric potentials gradient (ΔV) and the 1/electric resistance (1/R) of copper.

$$I \approx f\left(\Delta V, \frac{1}{R}\right) \tag{18}$$

Electric potentials gradient - electric resistance - electric current corresponding to Ohm's law analytic solutions of force, character, and response for the charges transportation,

$$I = \frac{1}{R} \cdot \Delta V \tag{19}$$

are proportional to analytic solutions of force, character, and response corresponding to as follow:

12. Analytic Solutions of Forces Gradient, Strength Coefficient, and Plastic Deformation

Forces gradient, strength coefficient, and plastic deformation are solved by replacing the all interactions of atoms of steel-environment, the abilities of atoms to resist atoms inter – atoms planes translations from steel to environment, and the atoms inter – atoms planes translations from steel to environment functions with steel-environment forces gradient, steel force per cross sectional area, and steel inter – atoms planes translations frequencies stages approximations. Steel-environment forces gradient, steel force per cross sectional area, and steel inter – atoms planes translations frequencies stages are ways of solving forces gradient, strength coefficient, and plastic deformation. Forces gradient, strength coefficient, and plastic deformation are analytic solutions of force, character, and response for the deformation for atoms. Coupled investigation serves to verify analytic solutions of force, character, and response for the deformation and confirms the interpretation of the deformation equation for atoms.

For that matter, the deformation is a differentially analytic solution response that determines the all temporary or permanently atoms inter – atoms planes translations from steel to environment at atoms sequences. Translation (motion) obeys two modes as elastic mode and plastic mode. Translation of elastic mode not breaks atoms bond as dislocation. Translation of plastic mode breaks atoms bond as dislocation. Plastic deformation occurrence is often phenomenologically based on dislocation motion from steel to environment and responseless boundary change, as long as the dislocation and the responseless boundary are a transportable dislocation and a changeable boundary.

Provided that, the strength coefficient is a differentially analytic solution character that determines the all abilities of atoms to resist permanently atoms inter – atoms planes translations from steel to environment at atoms sequences. Since the permanently atoms inter – atoms planes translations from steel to environment exist the interactions of atoms of steel-environment and the abilities of atoms to resist permanently atoms inter – atoms planes translations from steel to environment exist. A unit phenomenological differential equation (20) determines the 1/strength coefficient multiplying steel or matter cross sectional area subjected to force F_i ($1/\kappa.A_i$) which is proportional to inverse of the plastic deformation $\{\ln(1+\Delta l / l_0)\}^n$ of steel.

$$\frac{1}{\kappa \cdot A_i} \approx f^{-1}\left(\left\{\ln\left(1+\frac{\Delta l}{l_0}\right)\right\}^n\right) \tag{20}$$

Furthermore, the plastic deformation is a differentially analytic solution response that determines the all permanently atoms inter – atoms planes translations from steel to environment at atoms sequences. The permanently atoms inter – atoms planes translations from steel to environment are proportional to the interactions of atoms of steel-environment and inversely proportional to the abilities of atoms to resist permanently atoms inter – atoms planes translations from steel to environment. A unit phenomenological differential equation (21) determines the plastic deformation $\{\ln(1+\Delta l / l_0)\}^n$ which is proportional to the forces gradient (F) and the 1/strength coefficient multiplying steel or matter cross sectional area subjected to force F_i ($1/\kappa.A_i$) of steel:

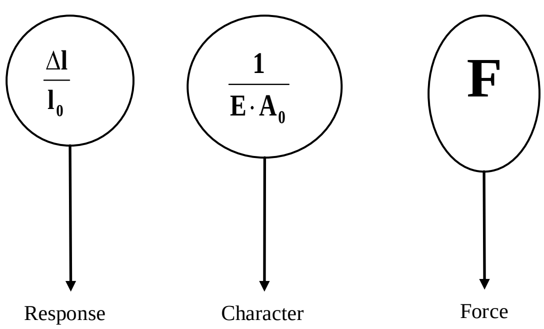
$$\left\{\ln\left(1+\frac{\Delta l}{l_0}\right)\right\}^n \approx f\left(F, \frac{1}{\kappa \cdot A_i}\right) \tag{21}$$

12. 1. Elastic Deformation

Forces gradient - strength coefficient - elastic deformation corresponding to Hooke's law analytic solutions of force, character, and response for the mechanic behavior,

$$\frac{\Delta l}{l_0} = \frac{1}{E \cdot A_0} \cdot F \tag{22}$$

are proportional to analytic solutions of force, character, and response corresponding to as follow:



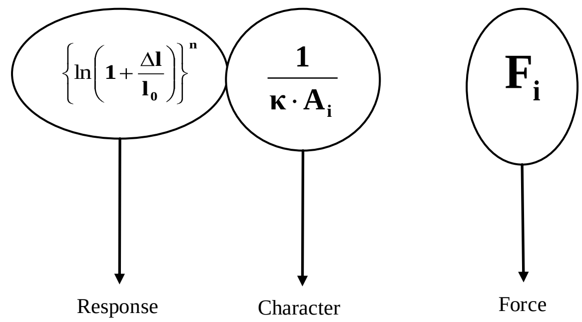
A_0 is fromerly steel or formerly matter cross sectional area subjected to force F, E is Young's Modulus, and (Δl / l_0) is engineering strain relatives to formerly length at one axis direction.

12.2. Plastic Deformation

Forces gradient - strength coefficient - plastic deformation corresponding to plastic deformation analytic solutions of force, character, and response for the mechanic behavior,

$$\left\{\ln\left(1+\frac{\Delta l}{l_0}\right)\right\}^n = \frac{1}{\kappa \cdot A_i} \cdot F_i \tag{23}$$

are proportional to analytic solutions of force, character, and response corresponding to as follow:



A_i is steel or matter cross sectional area subjected to force F_i, κ is strength coefficient, n is strain hardening coefficent, and $\{\ln(1+\Delta l / l_0)\}^n$ is true strain relatives to formerly length at a moment one axis direction i.

13. Acknowledgment

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14. References

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15. Symbols and Abbreviations (units)

α	thermal conductivity (1 / K)
α	linear thermal expansion coefficient (1 / m)
A_0	intial cross sectional area (m2)
A_i	actual cross sectional area (m2)
B	induction magnetic
C	character (arbitrary unit)
ΔT	temperature difference (K)
ΔC	concentration difference (mol / l)
$\Delta l / l_0$	engineering strain (%)
$\partial C / \partial t$	concentration rate (mol / l / s)
$\partial^2 C / \partial x^2$	a moment concentration gradient

$\partial l / l_0$	a moment engineering strain (%)
$\partial T / \partial t$	temperature rate (K / s)
$\partial^2 T / \partial x^2$	a moment temperature gradient
D	diffusivity
E	young's Modulus (MPa)
EMF	electro Chemical Force (Volt)
F	force (N)
F_i	a moment Force (N)
H	field magnetic (tesla)
I	electric current (ampere)
κ	strength coefficient (MPa)
$\{\ln(1+\Delta l / l_0)\}^n$	solid metal true strain (%)
μ_0	permeability magnetic
n	strain hardening coefficient (dimensionless)
r	resistance (arbitrary unit)
R	electric resistance (ohm)
R	response (arbitrary unit)
T	temperature difference (F)
V	electric potential (voltage)