1– Introduction

1– 1. General Introduction:-

Processes involving the chemical transformation of solids play an important role in modern technology as sophisticated and costly solids can produced by reaction of cheap precursory solids. To obtain the desired purity, structure and texture of the material, a contrast of reaction is necessary [1].

There is often an intimate relationship between the physical properties of a solid and its chemical composition or chemical processes within it. In particular, many properties depend upon deviation from the ideal structure to understand and control them we must turn to the chemistry of solids. Recently, several metal oxides having the general formula AB_2O_4 have been investigated [1] as they exhibit interesting properties. In these oxidic spinels the physical properties were found to be dependent on the nature of the ions involved, their charges and their site distribution .

Magnetite, Fe_3O_4, is the key system for all spinel ferrites, $Fe_{3-x}M_xO_4$, M representing a metallic constituent such as Cu, Mn, Zn, Ga, etc. There exists a vital interest in a more detailed knowledge of all material parameters of both the as-perfect basic material and its derivatives [2].

The low cost, easy manufacturing makes polycrystalline ferrite one of the most important materials today. They are attractive subjects for continuous scientific interest and have been deeply investigated in material sciences, because of their physic-chemical properties. Generally, ferrites with the general formula AB_2O_4 are a class of chemically and thermally stable materials suitable for a wide variety of applications including catalysis [3], magnetic recording media and magnetic fluids for the storage and /or retrieval of information [4],magnetic resonance imaging (MRI) enhancement [5], magnetically guided drug delivery [6], sensors [7], pigments [8], etc. It is established that various binary and ternary spinel ferrites are effective catalysts for a number of industrial processes such as oxidative dehydrogenation of hydrocarbons [9], decomposition of alcohols and hydrogen peroxide [10], treatment of automobile-exhaust gases [11], oxidation of various compounds such as CO [12], H_2, CH_4 and chlorobenzene [13], phenol hydroxylation [14], alkylation reaction [15], hydrodesulphurization of crude petroleum [16], catalytic combustion of methane [17], and in the fabrication of multilayer chip inductor (MLCIs) as surface mount devices for miniaturized electronic products such as cellular phones, digital diaries, video camera, recorders, floppy drives, etc.[18].

The use of ferrites for certain application depends on its electrical and magnetic properties, which in turn are sensitive to the preparation condition as well as the type and amount of substitutions. The useful properties of ferrites can be achieved by careful control of both composition and structure [19].

Most ferrite materials behave as semiconductors and have attracted considerable attention in the field of technological application in a wide range of frequencies extending from microwave to radio frequency[19]. Polycrystalline ferrites have very good dielectric properties that depend on several factors such as processing conditions, sintering temperature and time, chemical composition and substitution of different ions [20]. It was proposed that the air-sintered ferrites are characterized by relatively high conductive grains separated by high resistive thin layers (grain boundaries) [21]. Most of the external applied electric field to the specimen is concerned within the grain boundary regions. Therefore the electrical properties of the grain boundary phase control the electric and dielectric properties of these materials.

Materials for spintronics (spin-based electronics) such as ferrites combine the complementary properties of ferromagnetic material systems and semiconductor structures. In the so called *diluted magnetic semiconductors* (DMS) a stoichiometric fraction of the host semiconductor atoms is randomly replaced by magnetic atoms and the resulting solid solution is semiconducting, but can possess well-defined magnetic properties (e.g., paramagnetic, antiferromagnetic and ferromagnetic) that conventional semiconductors do not have.[19] One of the systems which attracted more attention is that the appearance of ferromagnetism above 298 °K in the $Zn_{1-x}Mn_xO$ system.

Dielectric behavior is one of the most important properties of ferrites, which markedly depend on the preparation conditions, e.g. sintering time, and temperature, type and quantity of additives. The study of dielectric properties produces valuable information on the behaviour of localized electric charge carriers leading to greater understanding of the mechanism of dielectric polarization in the ferrite samples.

Spinels of transition metal oxides such as manganites $Mn_{3-x}M_xO_4$ (M = Ni, Cu, Fe, Co, etc.) are also used as negative temperature coefficient (NTC) thermistor materials owing to their interesting electrical properties. NTC thermistors are widely used in a variety of industrial areas such as automotive, cellular phone, telecommunication, and aerospace, e.g., elements for the suppression of in-rush current, for temperature measurements and control, and for compensation for other circuit elements. [18, 22 and 23] The selection of a