5.0 INTRODUCTION:

Bimetallic nanoparticles are the combination of two metals of the nanoscale size range. This area of nanoscience is of interest in the field of catalysis as bimetallic nanoparticles which can exhibit synergistic effects.

Bimetallic nanoparticles can be classified into four types of mixing patterns:

1) core shell nanoparticles
2) subcluster nanoparticles
3) mixed nanoparticles and
4) multishell nanoparticles

Bimetallic nanoparticles which are composed of two kinds of metal elements can have crystal structure similar to the bulk alloy as well. In addition they can adopt another type of structure in which the distribution of each metal element is not found in the bulk. Such structures defined by the distribution modes of the two elements, include the random alloy, alloy with an intermetallic compound type, cluster-in-cluster and core shell structure.

1] Core Shell Structure:
In core shell structure one metal element forms an inner core and the other element surrounds the core to form a shell.

2] Cluster-in-Cluster:
In the bimetallic nanoparticles with cluster in cluster structures one element forms nanoclusters and the other elements surrounds the nanoclusters and acts as a binder. The cluster in cluster structure may be considered as a modification of the core shell structure. Schmidt et al. [1] reported Pd core–Au shell and Au core–Pd shell bimetallic nanoparticles prepared by a successive reduction process.
However, by successive alcohol reduction of PdCl$_2$ and AuCl$_4$ one cannot always obtain homogeneous bimetallic nanoparticles.

### 3] Alloy Structures:

In bulk metals, two kinds of metal elements often provide an alloy structure. If the atomic sizes of two elements are similar to each other, then it will be a random alloy. When the atom sizes are quite different from each other and the mole ratio of the two elements are simple and adequate to the structure, then they form an intermetallic compound. In the case of bimetallic nanoparticles these kinds of alloy structures seems to be more easily produced than in the case of bulk metals. In fact, we have found that bimetallic nanoparticles between precious metals and light transition metal have such alloy structures.

#### 5.0.1 Bimetallic Nanopartilces And Clusters: A Brief History

Much of the early work on nanoscale bimetallic systems came from the study of transition metal carbonyl clusters in the 1960s. Further studies on a wide range of molecular precursor derived, bimetallic clusters continued throughout the 1980s and into the 1990s with an emphasis on structural characterization by EXAFS [2-4]. This period of work also began studying the catalytic behavior of platinum group metal (PGM) bimetallic nanoparticles from a synergistic viewpoint whereby the combination of two metals together enhanced the catalytic activity or selectively relative to the monometallic components by themselves [5-6]. Surface science research then moved on to more complex bimetallic alloyed and over layer surfaces with the goal of understanding how two metals worked synergistically to give higher catalytic activity or selectivity than the monometallic components on their own. The development of synthetic methods for making bimetallic nanoparticles of analogous architectures (alloy and core@shell) was then in its infancy while the understanding of
catalytic activity at bimetallic surfaces was well underway. In the past decade, we would see these two areas begin to converge leading to a greater understanding of complex and industrially relevant catalysts having nanometer diamensions.

Since the middle of 1990s the groups of Toshima [7-9], Bradley [10-13], Crooks [14-16], El-Sayed [17-19], Cheon [22-22], Somorjai [23-26] and others have developed and characterized small colloidal alloy and core@shell bimetallic nanoparticles prepared primarily from metal salt reduction methods along with breaking new ground in the development of methodologies for synthesizing increasingly complex bimetallic nanoparticles. These groups performed many of the initial catalytic studies aimed at elucidating the relationships between well-characterized bimetallic nanoparticle structures and their function as catalysts. Toshima and coworkers as well as Bradley and coworkers have performed extensive studies on the Pd-Cu alloy system with the goal of elucidating the particular alloy structure by EXAFS measurements [27]. The ability to synthesize desired architectures of bimetallic nanoparticles opens up new avenues for creating unique catalytic materials with high activity and selectivity for important catalytic transformations.

In the present study Cu-Ag and Cu-Mo bimetallic nanoparticles are synthesized by the electrochemical reduction method using tetra alkyl ammonium salt (TEAB/TPAB/TBAB) as a capping agent using current density of 6 and 10 mA/cm². The characterization of the synthesized nanoparticles is done by using different analytical tools.