



# INTERDISCIPLINARY APPROACH TOWARDS NEW FUNCTIONAL MATERIALS IN SMALL INSTITUTIONS

**M.Venkata Ramana**

Professor

Department of Physics

Anurag University, Venkatapur, Hyderabad 500088, India.

*Interdisciplinary - “research, teaching, or problem solving that integrates several disciplines to create a unified outcome” - James Collins*

The systematic study of correlating the properties with the structures of materials has become the topic of interest for the for the past few years. This area has established an ideal interface between chemistry, material science, computer science, physics, instrumentation, chemical engineering and biology. Conventionally, a study of synthesis, structure and properties of solid compounds constitutes solid state chemistry and there has been considerable effort in classifying the solids based on the observed properties. With the recent developments in Nanotechnology, an interdisciplinary approach towards the development of materials has been in practice. It is very difficult at small institutions to work with materials and their science and engineering due to lack of infrastructure and expertise. In this talk, more attention is paid to materials, synthesis and their importance with due participation of different departments of smaller institutions by crossing the boundaries of the walls that are constructed for long years. The change in mindset of the individuals plays a important role in this interdisciplinary approach.. The role of different branches of science and technology in the material processing and engineering is also discussed. The need of exchange of knowledge and sharing of ideas among different disciplines towards the engineering of novel materials is presented. The result of this approach in the development of nanoparticles, nanocrystals, their chemical synthesis, antibacterial studies and other studies will be discussed.

When we were young, the research in our Universities is confined to the individual laboratories. What is going on within those walls is known only to that particular group of people. In fact, there are even situations wherein some of the people of their own team doesn't know what is going on in their own laboratory. Gone are those days now and better results and good research is being done and will be done only with sharing of the knowledge among number of branches of science, Engineering, Technology and other allied subjects. Arts and Social Sciences are not exemption.

When people from different fields work together on a single problem, it is known as multi-disciplinary. When few people belonging to different fields work together to create a common new problem of research and forges a new dimension, it is termed as “inter-disciplinary”. From the past, the challenge to the society is always “New materials”. Thus most of the research is focused around the materials. Different metals dominated the time periods. The development of alloys opened different eras, Large number of people still working in materials and people are trying to get hold over the properties of materials. Already number of parameters of alloys are under the control of human beings.

A better way of completing a task, these days, is involving services of number of branches of the present day available resources. Take for example, monitoring the temporal risk of cholera transmission. A team has to identify where the problem is. Care has to be taken by the concerned, not to further aggravate the problem. The information of the cholera affected area has to be monitored continuously. The best possible solution for the monitoring is through satellite. Huge communication network, computer simulations and electronics is involved in this. In fact, this is the way the present day diseases are being under control and monitoring by world organizations.

Recognizing the importance of the interdisciplinary research, many Universities and Laboratories have launched several programs of this nature in their regular activities. Even Govt. of India is also encouraging projects of interdisciplinary nature. Experts of one

area are given projects in another upcoming areas. There are instances, where one expert of one field is given research supervisorship in another area of his interest. This has made researchers sky a limit.

The best known Bio-X program of Stanford University involves: biocomputation, genomics, biophysics, chemical biology, science of brain and behavior, regenerative medicine and biodesign. This program can be taken as one of the best examples for the interdisciplinary initiative by the Stanford University.

The urge for the new avenues and new materials in science and technology has opened the doors for a complete new era. Recently, I came across an article “ Is science becoming more interdisciplinary? Measuring and mapping six research fields over time” by Ian L. Porter and Ismael Rafols in *Scientometrics*. This article is well articulated and deals with the new emerging trends in materials and in general the whole science. The barriers between the individual subjects and fields are no more.

For almost any scientific service or otherwise contribution to the society, a visualization is necessary. This visualization involves, design, implementation and evaluation of novel methods for more accurately, intuitively, and effectively conveying information through images. The present day visualization of scientific problem has become an inherently interdisciplinary effort, involving the integration of insights from vision and perception with inspiration from art and illustration, and algorithms from computer graphics, computer vision, and mathematics, along with human subjects experiments.

Most of the basic science research is done at our universities and colleges. The work done here will become the basis for the applied science research, which is mostly taken up by the industry research laboratories. This leads to the technology research which is confined to Industries. This leads to the prosperity of the society which is then show interest in investing more on basic science. Hence in order to serve the society by giving the fruits of research to the society, it is necessary now-a-days to do carry out interdisciplinary research at basic level i.e in colleges and Universities.

The scenario of the small institutions is different. Hardly one or a few people with individual specializations will be interested in one's one area. The facilities for the research is also limited as the ideas of one's own. Because of number of constraints people working in the small institutions are giving up contributing to the one of the key aspects of progression of nation. It is an often heard answer from these institutions, What can I do within these conditions?. The only possible solution is the Inter-disciplinary attitude towards the basic research. Another thing is, one should come out of the virtual walls built under the title of their respective subjects. Think with a strong participation in the wide spectrum of the problem. It is the results that one think should be kept aside at this thinking process. It is necessary to share the ideas with the colleagues of various subjects in one's institution and simultaneously the ideas of theirs should also be equally respected and should be given importance. Sometimes the ideas of others may yield positive results. It should be made a practice of the facilities that are available within the institution, nearby institutions, used by other groups and Central facilities established by various Government organizations. The basic research equipment should be pooled at centrally accessible place and should be used by all the staff of the institution and this should also be an extended facility for other other institutions. Taking the help of colleagues in analysis of the data and writing a research article is also equally important. It is often found that the manuscripts submitted by authors are very poor in language and development. This should also be given attention. In essence, the key is barriers and boundaries among people, subjects and institutions should be broken and working as a team is important, not as an individual.

Long back, Ortega Gasset recognized that fragmentation among the fields and specialization was dysfunctional and must be balanced in the future by the “genius” for integration. Number of Universities and Governments abroad have already initiated interdisciplinary laboratories, projects, schemes and Research agencies, identifying the importance of the interdisciplinary research. There is a radical administrative innovation, and disciplinary integration in the western countries.

The emergence of Nanoscience and Nanotechnology has opened the doors for interdisciplinary research. It is established that interdisciplinary collaboration between the humanities and nanoengineers for scientific research leads towards socially beneficial results. Biological samples have become templates for the preparation of nanomaterials. Leaf, root, flower and seed extracts have become major components in Green synthesis of materials. Chemistry is the dominant science in nanostructural materials. Glass science has also its own role in nanomaterial synthesis. Conventional glass, Sol-Gel glass and semi-glass have become a route for nanocrystals and nanoclusters. Medicine and Pharmacy are using the nanomaterials for the immediate welfare of the human beings. Number of drugs, pharmaceuticals and medicines have now been prepared by using the interdisciplinary approach. Thin films, Laser ablation, CVD and other advanced techniques are now being used by workers of different branches.

If we look at the research publications of Journal of American Chemical society, JACS, the total publications of an year were contributed from Physics, Chemistry, biomedical sciences, material sciences, Mechanical engineering, Electrical engineering, Chemical engineering, Information technology and Computer science. This indicates how dramatically there is a shift in the

perceptions of the researchers. Most of these fields were collaborated with each other for number of the papers. There are instances of more than four departments collaborating with each other and working in the same problem.

The new material synthesis has erased the interdisciplinary borders between physics, chemistry, molecular biology – and engineering sciences. The scientific ambition is to link and to amalgamate quantum mechanics, solid-state physics, inorganic chemistry, and molecular biology. These new materials like nanomaterials have become a key research materials for most of the scientific community these days.

The chemical and structural properties are the basic properties of materials. These can be engineered and modified by changing their properties with respect to electrical, optical, mechanical and magnetic properties depending upon the requirement. The interdisciplinary attitude has brought significant change in the rate of new material processing.

New Alloys lead to lighter, stronger and tougher materials. New techniques of bandgap engineering were developed. Reinforced fiber materials were born only due to interdisciplinary research. Biodegradable polymers, biological tissue based polymers, biocompatible polymers and conducting polymers were developed .

Nanoscience has become a genuine interdisciplinary field, with contributions emerging from a very special combination of chemistry, biology, engineering, and computer science. Siegel says “Nanostructure science and technology is a broad and interdisciplinary area of research and development that has been growing explosively worldwide in the past few years. It has the potential for revolutionizing the ways in which materials are produced and products are created”.

Nano structures are like nanomachines and are objects of interest to engineers, who can manipulate the atoms to create mechanisms; biologists, who can begin to understand how the smallest organisms function; physicists and chemists, who can investigate the properties of substances such as gold by understanding the nanostructure of gold, as it were, and so on.

A good paradigm of nanotechnology is a self-assembling object whose operation is best understood as part chemistry, part physics, part biology, part computing, and part engineering – all of which projected into the nanometer realm. Thus the interdisciplinary research and interdisciplinary outlook has become the order of the day.

*Finally*, As Rita Colwell put it, We should always be looking for leaders who can foster interdisciplinary connections and thus advance the scientific enterprise.