Executive Summary

Title of Research Project:

DEVELOPMENT OF ECO FRIENDLY AND HIGH DENSITY NANOCRYSTALLINE MULLITE RICH CERAMIC PIGMENT/FILLER FROM LOW COST CERAMIC MATERIALS/FLY ASH

Reference No. : **[UGC F.42-772/2013(SR)]; Date - 14.03.2013**

The major research project entitled "**Development of Eco Friendly and High Density Nanocrystalline Mullite Rich Ceramic Pigment / Filler From Low Cost Ceramic Materials / fly ash**" contains three comprehensive experimental endeavours which successfully fulfil the major objectives mentioned in the project.

First part of the work focuses on a simple low temperature synthesis of coloured ceramic pigments developed from the metal oxides viz. Cu(II), Ni(II), Cr(III) and Fe(III) imbibed in the clay kaolinite. Characterization of the prepared samples by means of XRD & FTIR and their analysis confirmed the proper incorporation of metal oxides in kaolin; SEM captured the surface morphology of the pigment samples and vibrant colours are visually observed due to the incorporation of metal oxides. The transition metals have unfilled electronic shells and possess high polarizability. The formation of the complex ions of these metals due to the incorporation of oxygen, shifts the absorption band in the visible region of the electromagnetic spectrum giving rise to a wide range of coloured pigments. Furthermore, PEG analysis and antimicrobial potency of these samples conferred that these coloured composites can serve as a promising ceramic pigment material in paint systems. Easy availability of kaolin and development of method of processing at low temperature will reduce their production cost which will be an added advantage to the paint industry.

Second part of the work has successfully demonstrated the innovative exploitation of fly ash. Fly ash is generated in huge quantities in Indian thermal power plants creating serious environmental pollution and health hazard, whereas Sillimanite is a by-product generated during extraction of rare earth compounds from beach sand minerals available in the Indian sea-coast. Both are used as major precursors for the cost effective production of attractive coloured ceramic pigments by calcination in an environmentally friendly process which can find its potential in ceramic industries.

Third part of the work has developed multifunctional ceramic composite pigments by incorporating transition metal ions in conjugated mullite The higher densification (~ 99% relative density for nickel ion doping), moderate hardness and high values of Young's modulus due to different ion doping make these composites not only useful in structural application, but also as ceramic pigments in paint systems due to the formation of coloured aluminate spinel phases. The highest value of hardness (~8.7 GPa) and Young's modulus (~207 GPa) was found for highest doping concentration of copper and cobalt ions respectively. Higher dielectric constants of pure (~ 91) and metal ions doped mullite composites (~ 175 for 0.06 (M) nickel chloride doping) have revealed a wide scope for these

composites in electrical applications like ceramic capacitors. Prominent fluorescent properties in both UV and visible region resulting from oxygen defect structures with highest fluorescence intensity obtained for cobalt doped mullite composites make it suitable for optical applications too.

We expect that these developed ceramic composites with unique combination of physicochemical, dielectric, mechanical and photoluminescence properties will have promising structural, electrical and optical applications in everyday life.
