Format for submitting projects under Project Varanasi. (Do not change the serial no and headings of the items. If the headings are not relevant to your project then say so. The proposal document must not exceed 5 pages.)

1	Project type (Strike off those not applicable, refer to the policy document for project types)	(i) Technology Development or Prototype Development. ~~(ii)~~ ~~Faculty Projects (Innovation and application Projects)~~ ✘ ~~(iii)~~ ~~Project (Student Nurturing)~~ ✘
2	Title of the Project	To develop low temperature ceramic colors to decorate ceramic wares, especially for Varanasi and Chunar Potters
3	Duration of the project	1 year
4	Total Cost	
5	Name address and phone numbers of PIs and Co-PI's and Student PI's	Dr. Vinay Kumar Singh, Associate Professor, Department of Ceramic Engineering, IIT(BHU), Varanasi-221005 Email: vinaycer@gmail.com Mob:9936182124

6. General Description of the project:

Traditional work of pottery is in practice in Varanasi since hundreds years and at its nearby places such as Chunar. There are number of small scale potters, manufacturing red and white earthen ware for their earning. They have skill in fabrication but they lack of knowledge of raw materials and preparation of colors to decorate items. Moreover they fire the articles relatively at lower temperature as compare to ceramic industries. Therefore, they also require various colors which can be fired at very low temperatures to decorate their items and can enhance the market price of their products.

The objective of the proposed proposal will be to provide technology and knowledge of material resources for the manufacturing of ceramic colors with various shades. Colours will be made by inorganic pigments produced by calcination to high temperature of metallic oxides. Controlling their thermal stability, chemical resistance and appropriate particle size will provide our pigments with high colour intensity. Their easy dispersion will make them optimal for any type of colouration. These pigments

will be further mixed with prepared low temperature glass frits with excessive fineness so that the mixed products will be suitable to use them at low temperatures. These ranges of colours will be especially designed and produced for coloured and white earthenwares, which are the main products of Varanasi potters. These products will also give outstanding homogeneity and stability without modifying the firing conditions of the body.

7. General Description of experience/ expertise of team on such/ similar projects

P.I of the proposed project is from ceramic engineering background. He has done his B.Tech, M.Tech and Ph.D in Ceramic Engineering. Apart from this, currently he is actively engaged in academic and research activities in the field of pottery and porcelain. Also he is currently dealing one DST project on manufacturing of dental products of different shades.

8. Deliverables (The deliverables are to be described in each section. If there is no deliverable in a particular section then say the same clearly.):

(a) Prototype: See the process prototype

(b) Process Prototype: A complete process will be developed and documented step by step for the manufacturing of ceramic colors with various shades. In the first step, pigments and combination of coloured oxides will be tried to obtain stains of different colors. Then glass frits will be prepared for maturing in the temperature range of 600-1000^{0}C. Frits are the main components of nearly all ceramic glazes and colours, present in many compositions of different materials where a glossy surface is needed, even if only as a fluxing agents are required. Fritting is the process of melting glass and subsequent quenching. It also permits to use water soluble constituents as after fritting the constituents will be water insoluble. Finally the proportion of pigments and glass frits will be optimized as a mixture to obtain its suitability as per requirements.

(c) Design/ Technical Document: Technical documents will be prepared with all details such as process, raw material selection, proportioning of raw materials, compilation of composition of ceramic colours, maturing temperature, physical and chemical characteristics.



(d) Software; Same documents can be provided as a soft copy
(e) Document (audio, visual, write ups web sites etc): Write up for the same can be provided
(f) Any other: As per requirement

9. Method/ Technology to reach the deliverable. (A detailed description of method or technology may be described)

As discussed above, the first step of the proposed project will be to prepare ceramic colorants. The common raw materials will be various colored oxides and their combination. The final colour obtained from coloring agents is considerably influenced by the other constituents of the compounded stain. Therefore, successive batches will be prepared for the same colour with carefully weighing and mixing. Calcination is the main part of the preparation of ceramic colorants. Several different reactions may occur, depending on the nature of the raw materials and the desired end products to control during calcination. The temperature of the calcination will be decided and will be at least equal to that at which the stain will subsequently be fired on the ware. After calcination, the colorants will be crushed and then washed to remove all soluble matter. The insoluble residue will be further wet ground to desired fineness.

Low temperature glass frit is invariably present in most types of ceramic colorants. Fritting helps to use water soluble materials and make them water insoluble. Therefore, this is the primary reason for fritting colorants, but the process serves a number of other purposes with regard to the production of a good colorants. Required low temperature frits will be prepared with nontoxic raw materials, so that the colorants can be used in number of applications.

Further optimization of mixes for their colorants combination and frit proportion will be done to get better suitability in number of applications. Finally these products will be tested for their physical and chemical properties. Interaction with Varanasi potters will be done and technology of process will be provided to them.

10. Time line / mile stones for achieving the deliverables.

Pigments and combination of coloured oxides will be tried to obtain stains of different colors. Then glass frits will be prepared for maturing in the temperature range of 600-1000^{0}C	Powders characterization. Formulation of mixes and their testing	Application of colourants on ceramic wares and Interaction with Varanasi potters. Preparation of documents of process as hard copy as well as soft copy
First two months	Work to be done in next six months	Work to be done last four months