

### DECLARATION BY THE CANDIDATE

I, *ARUP KUMAR MANDAL*, certify that the work embodied in this thesis is my own bonafide work and carried out by me under the supervision of *DR. OM PRAKASH SINHA* from *JULY 2012* to *DECEMBER 2016* at the ‘*DEPARTMENT OF METALLURGICAL ENGINEERING*’, Indian Institute of Technology, Varanasi. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credits to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not willfully copied any other’s work, paragraphs, text, data, results, etc., reported in journals, books, magazines, reports dissertations, thesis, etc., or available at websites and have not included them in this thesis and have not cited as my own work.

Date:

Place: Varanasi

(ARUP KUMAR MANDAL)

### CERTIFICATE BY THE SUPERVISOR

It is certified that the above statement made by the student is correct to the best of my knowledge.

**Supervisor**  
(Associate Professor)  
Department of Metallurgical Engineering  
IIT(BHU), Varanasi

**Signature of Head of Department**