Data points has been collected from simulation for four different clad bead heights, h and different laser power inputs, P which has been listed

i) Clad bead of height, h = 0.8 mm and width 1.2 mm

power(W)	width of HAZ w(mm)	depth of HAZ h(mm)	Radius of clad deposited(mm)
1000	1.3368	0.4506	0.625
600	1.208	0.0727	0.625

ii) Clad bead of height, h = 1 mm and width 1.2 mm

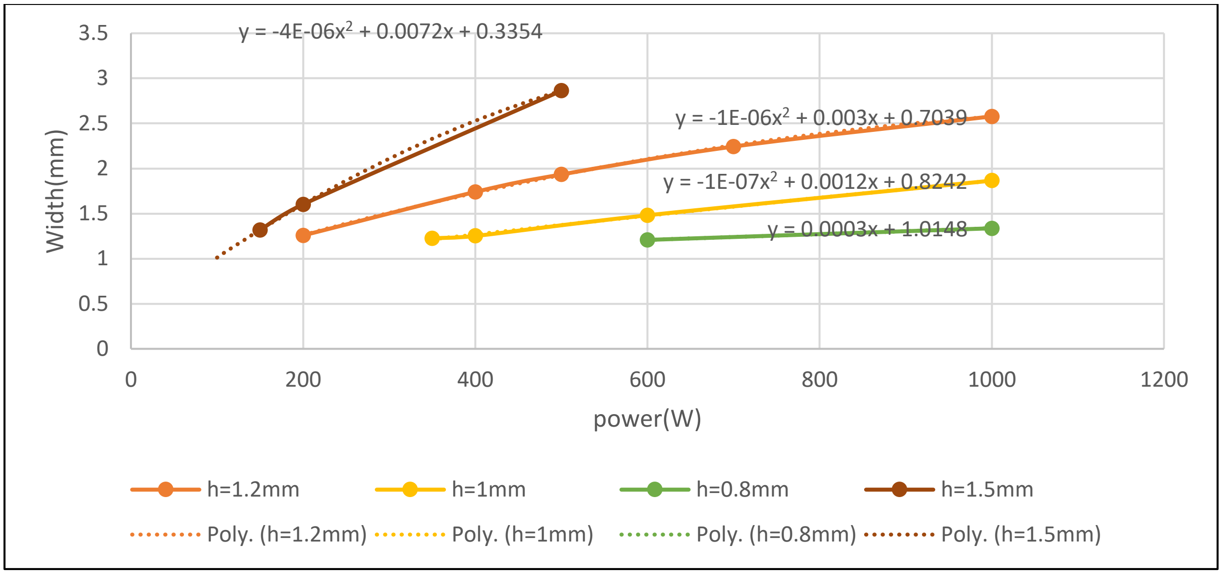
power(W)	width of HAZ w(mm)	depth of HAZ h(mm)	Radius of clad deposited(mm)
1000	1.8655	1.00379	0.68
600	1.48126	0.56594	0.68
400	1.25206	0.24927	0.68
350	1.22638	0.14664	0.68

iii) Clad bead of height, h = 1.2 mm and width 1.2 mm

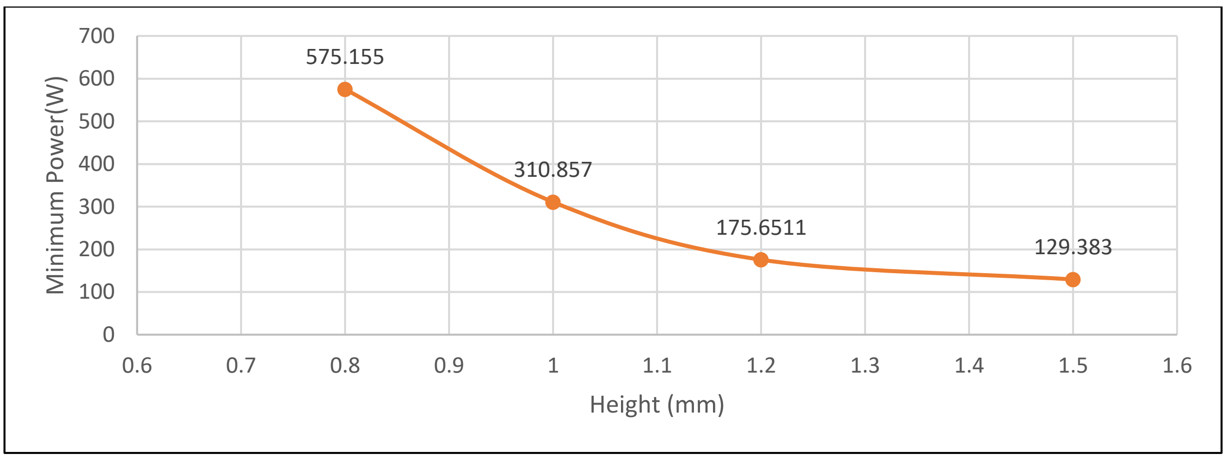
power(W)	width of HAZ w(mm)	depth of HAZ h(mm)	Radius of clad deposited(mm)
1000	2.578	1.893	0.75
700	2.2436	1.4943	0.75
500	1.9338	1.1021	0.75
400	1.7402	0.93503	0.75
200	1.25768	0.2893	0.75

iv) Clad bead of height, h = 1.5 mm and width 1.2 mm

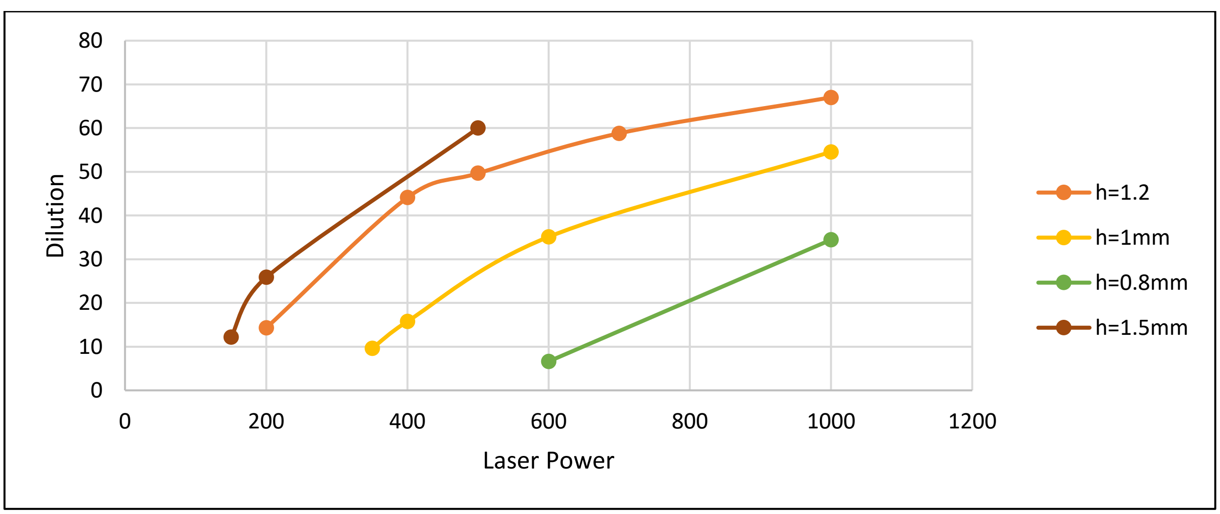
power(W)	width of HAZ w(mm)	depth of HAZ h(mm)	Radius of clad deposited(mm)
500	2.86198	1.62152	0.87
200	1.60274	0.63671	0.87
150	1.318	0.3274	0.87



Graph: Width of HAZ vs Laser Power



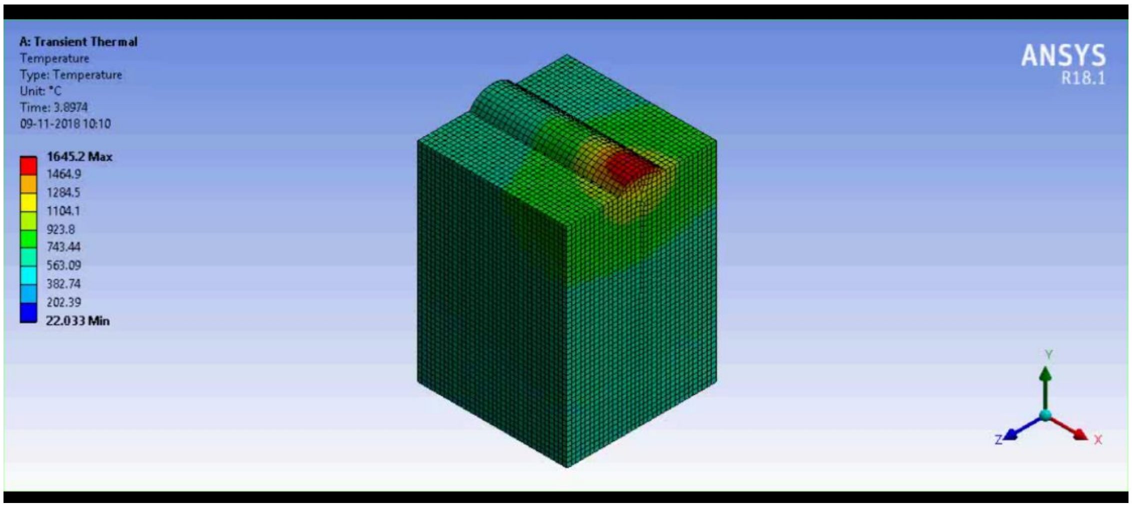
Graph: Minimum power vs Height of HAZ



Graph: Dilution percentage vs Laser power

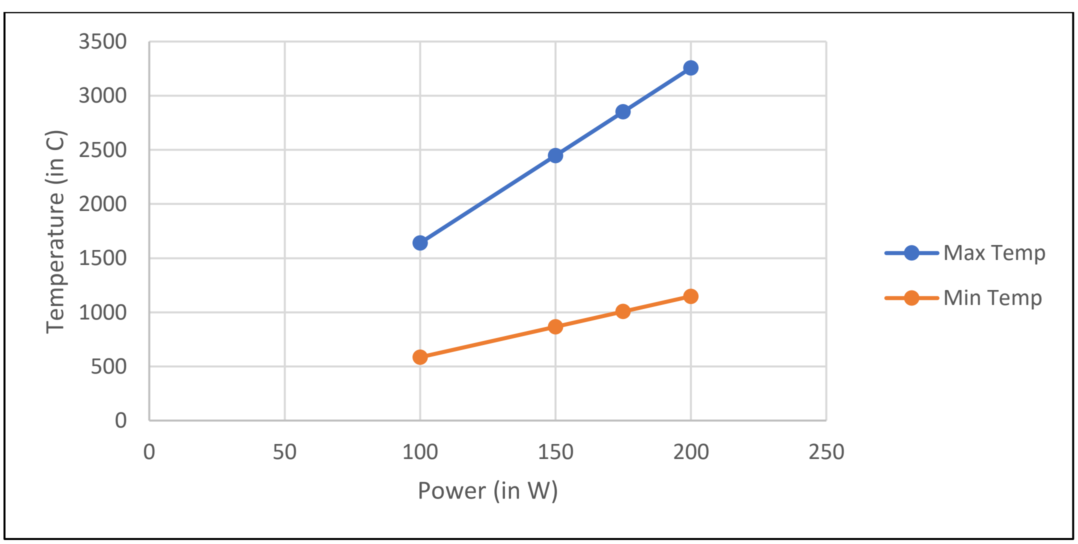
RESULTS AND DISCUSSION

The figure given below is a screenshot of simulation of the laser cladding process with input power of 100W



The maximum and minimum temperatures obtained for different power inputs:

Power (W)	Max Temperature (^{0}C)	Min Temperature (^{0}C)
100	1640	585
150	2447	866
175	2851	1007
200	3256	1148



In Graph: Temperature vs Laser Power

FUTURE SCOPE

Future investigations could revolve around analysis of how different parameters including but not limited to beam diameter, processing speed, speed of the particles and powder feed rate affect the temperature distribution. We were limited in our analysis since we checked for variation with laser power only.

Fig 5: Sample cladding process

ANSYS is a powerful modelling environment to work in, and we were unable to fully utilize the resources it provides. The effect of convection has been considered, while we have ignored radiation, due to the high temperatures it will also contribute to temperature distribution variation and its effect on the heat transfer in the melt pool could be considered for future work. The powder feeding system can also be modelled allowing prediction of clad height and powder temperature distribution in a single model.

Our original scope for work involved analysis of secondary variables which we would like to continue building upon. For phase transformation variation during the laser cladding process, we went through several papers. One of them was by Yiwen Lei, Ronglu Sun and Wei NiuAn. They used an X-ray diffractometer and scanning electron microscope with energy dispersive spectroscopy to analyze the microstructure and phase compositions of the coating. Thermodynamic calculation was performed with Thermo-Calc software based on a commercially available Alloys' database. The experimental results show that. The calculated results and experimental data indicated how the solidification process in the coating during laser cladding process proceeded from one phase to another. A solid-state phase transformation occurred after the solidification process.

It’s difficult to capture the temperature variation as discussed before, but we have seen great strides being made in technology and one of the potential methods include use of image processing during the process. This camera could be previously calibrated with a black body and it enables the surface temperature to be obtained. We can also obtain geometrical features of the track such as height and width in real time and obtain information related to the process parameters, and hence calculate the HAZ. Using this would also help us verify our simulations experimentally.

REFERENCES

1. http://www.lasercladding.co.uk/Laser-Cladding-Process.aspx
2. https://www.sciencedirect.com/science/article/pii/S0045794904000033
3. https://journals.sagepub.com/doi/full/10.1155/2014/291615
4. https://link.springer.com/content/pdf/10.1007%2Fs00170-016-9445-z.pdf
5. https://www.sciencedirect.com/science/article/pii/S1006706X11600149
6. https://www.sciencedirect.com/science/article/pii/S0143816603000630
7. https://link.springer.com/article/10.1007/BF02649723
8. https://www.ipgphotonics.com/en/applications/materials-processing/cladding
9. http://www.le2i.cnrs.fr/IMG/publications/130_Lasers%20in%20engineering-97.pdf
10. https://ac.els-cdn.com/S1875389211001623/1-s2.0-S1875389211001623-main.pdf?_tid=3ae4cdd4-bd64-46cf-aeb2-56c81cf1822c&acdnat=1542698366_9f6851afde5016d23dd8e935d93271c2
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