8.1 Distribution parameters

A parametric model between the arc parameters as a measure of the distribution parameters and the process variables has been established by a regression analysis using the experimental data. The shape of the projected area of the arc (area of incidence) is found to be semi-circular in the leading edge (front side) and is semi-elliptical in the trailing edge (rear side) in contrast to double elliptical as proposed by previous works. The semi axes of the area increase with current and arc length while it decreases with speed and electrode tip angle. The effect of current is the most significant whereas the effect of speed is the least.

8.2 Thermal efficiency

The thermal efficiency was determined through a combination of simulation and experiment, and a regression analysis of the data relating the thermal efficiency with the process variables was performed. It is found to be constant around 74% as opposed to a range of 40-80% quoted in the literature for a GTA heat source. Also, the thermal efficiency was found to be nearly independent of current, speed, electrode tip angle and arc length.

8.3 Heat and mass transfer modelling

Simplified heat and mass transfer models with enhanced conductivity and eddy mass diffusivity were developed, in contrast to the previous complex models. The predicted the melt-zone geometry and the alloying element’s surface concentration profiles are in excellent agreement with the experimental data.
The experimental and the predicted Ni concentrations decrease with the distance (depth direction), showing a well-recognizable gradient in the cases of both Bronze and Cast Iron substrates. In the width direction, the variation of the Ni concentration for the Bronze case with distance is marginal, thus lacking a gradient. However, the predicted values reasonably agree with the experimental data.

8.4 Wear Properties

It was possible to increase the hardness of Bronze from HV120 to HV185/HV175 by carrying out surface alloying with Ni/Cr, respectively. Hence, the surface alloying process developed in this study is viable and is capable of controlling the Ni/Cr content and the surface hardness, and tribological properties by varying the process parameters.
This study can be further extended as given below:

i) A spinodal hardening treatment may be given to the surface-modified Bronze with Ni in order to further improve its hardness;

ii) The SAP may be developed for Brass to increase its wear resistance;

iii) Surface alloying/modification can also be carried out with the addition of non-metallic particulates such as SiC, Al₂O₃ to assess the improvement in wear properties of Bronze and Brass;

iv) A study on the improvement of the corrosion property of Bronze as well Brass may be highly complementary to the present work.