Overview of Rapid Prototyping Based on GTAW

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The goal of the research presented in this paper is to investigate the mechanical and the physical properties of three-dimensional (3D) parts built by rapid prototyping (RP) based on gas tungsten arc welding (GTAW). In previously published papers, researchers showed the potential of RP based on welding (Dickens, et al.). They built various shapes (Norman and Dickens; Kovacevic et al.), and tried different hardware set-ups (Song, et al.; Kovacevic and Beardsley; Kmecko et al.), but only a few of the published papers investigated the properties of parts built in this manner (Spencer and Dickens). Initially, we observed the bead geometry as well as the physical properties. In those experiments, we deposited a bead by using different welding parameters combined with different heat transfer conditions. This involved the design of several experiments where beads are appropriately overlapped so that smooth surfaces (layers) are obtained. In those experiments, we used three different wire-feeding speeds and three different heat inputs (current). Material was deposited in one, two and three layers, so that the influence of the heat on the previous layer(s) could be analyzed. As a result, the effect of multilayer GTAW depositions for 3D objects could be accurately modeled using this technique.

The micrographic analyses of sections showed multiple horizontal bead structures with good structural integrity. Fusion between the beads was evident, as was adequate penetration. The micrographs revealed that the upper surface of the horizontal structure, having rapidly cooled, had a martensitic structure. Recrystallization due to multirun welding and the consequently slower cooling of the underlying layers resulted in finer ferrite/pearlite grains within the main body of the structure. 3D parts obtained by this technique exhibit good mechanical and physical properties, and since it is possible to produce parts of complex external and/or internal geometry (for example a profile of a turbine blade), it can be concluded that this technique has a promising future.

References

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