B. Engineered Weld Metal: Are Hybrid Welding Wires in Our Future?

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By use of alternating welding process parameters, deposition practice, and welding consumables during multiple pass welding, it is possible to improve weld metal mechanical properties. There are available a number of phenomena occurring during welding associated with the weld pool that allow weld metal designers the ability to generate macro- and micro-structural features amenable to implementation of composite theory. These phenomena include solidification microsegregation during dendrite growth, gas metal reaction between the selected shielding gas composition and specially designed weld composition, solidification microstructural orientation during welding, weld metal solidification modification during arc pulsing, and selected dual wire deposition to achieve dissimilar weld metal multiple pass deposition.

With proper selection of particulate added to steel cored wire, composite-like structure can be achieved in the sub-grain structure with dendritic core producing ductile rod-like shapes all aligned by the solidification process with interdendritic regions being a ductile matrix with strengthening precipitates. The precipitates can be a combination of carbides and/or nitrides with alternating shielding gas of pure argon with small additions of methane and nitrogen. The metal particulate-filled cored wire will only produce precipitates during the time when the reaction gas is shielding. With proper consumable composition design it is possible to achieve a pattern of ductile phase and strengthened phase that, when loaded, the ductile will yield enough to load the stronger phase, achieving a potential combination of both higher weld strength and toughness.

There are also advantages from using macroscopic phenomena such as alternating the weld travel direction or deposition to break the texture and any segregation behavior between weld passes. Reversing weld travel direction between passes in multi-pass welding will achieve grain refinement and reduce anisotropic tendencies in welds.

A variety of possible combinations to generate hybrid engineering designed welds will be introduced. The fundamentals associated with such depositions and practices will be described. The application opportunities to implement hybrid wire processing which achieve production and weld integrity advances will be identified.