

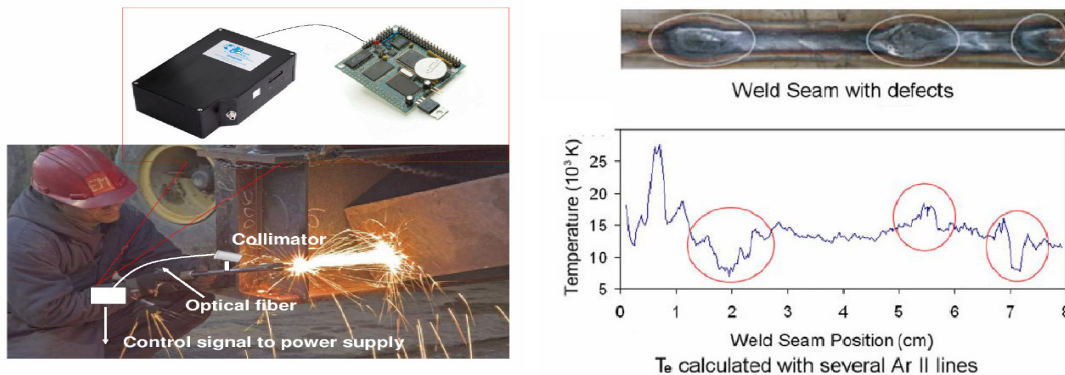
## Weld Quality Monitoring Based on Thermal Plasma Analysis

Currently, automated welding processes in the shipyard essentially run “open loop” with only the periodic observation of operational personnel due to the volume of welding being done. For a variety of reasons, the weld can end up with poor quality, such as oxidation, spattering, porosity and lack of penetration. Typical causes for such weld defects include the following: a) the contamination in shielding gas, welding wires and the surface of the work pieces, b) the environmental changes, such as strong wind, abnormal humidity, and adsorbed moisture on the electrode surface, c) fluctuations in shielding gas flux and welding current and the irregularity in the width of the welded materials, and d) insufficient experience of human operators. Consequently, it is a very challenging task to monitor the weld defects caused by the above-mentioned reasons.

Visual inspection, which is a post-process inspection, is the most widely used weld inspection method during the construction of naval vessels. The structural welds are visually inspected to ensure that they meet Navy specifications for size and workmanship. It is not uncommon for the same weld to be inspected a number of times as structures are assembled from components and erected into the final ship. Inconsistencies in visual inspections can mean that weld details that were accepted early in the process might be subsequently rejected during a re-inspection. This can lead to unnecessary repair cycles. A compact, low cost and in- process weld defects detection system is highly desirable as it can greatly reduce the extensive Non- Destructive Testing (NDT) procedures routinely performed to the welded pieces, thus leading to a substantial cost saving to the Navy.

In this program, AlphaSense, Inc. is developing a *compact, portable, and low cost in-process weld defects detection system*. The sensor system will have the following operational capabilities:

- Compact, lightweight, and wearable, compatible with welding process;
- Real- time online monitoring of welding defect and Automatic stop welding once defect is detected;
- Identification of defects resulted from a wide variety of causes, including welding current intensity fluctuation, wind speed changes, shielding gas flux variations, wire contamination, irregularities in welding materials;
- Less vulnerable to measurement noise as compared to electrical and acoustic sensor, thus lower false alarm.



**Figure 1:** A schematic of the compact, low cost and real- time welding defect monitoring system based on the plasma emission analysis.