D I A L

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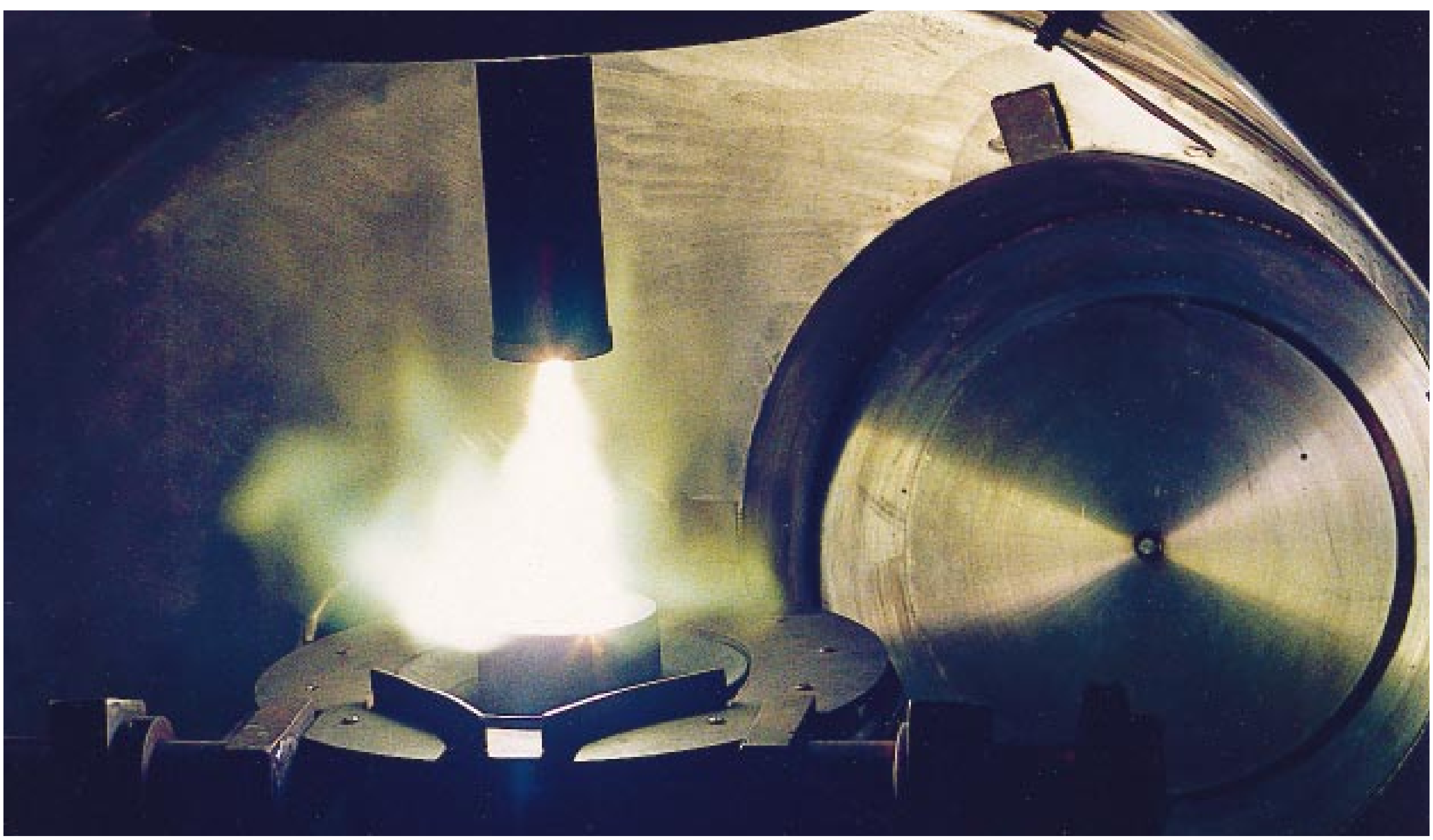
A Plasma Torch Electrode Health Monitor

DC plasma torches (Figure 1) are becoming increasingly important components in the disposal and vitrification of hazardous and radioactive waste. Major concerns include the need to prolong electrode lifetime, to prevent catastrophic failure, and to minimize system downtime. The lack of real-time information on electrode erosion prevents an accurate estimate of electrode wear and prevents the maintenance scheduling needed to achieve these goals. To rectify this situation, DIAL has developed an electrode health control monitor.

Electrode erosion occurs under the extreme operating conditions that are present at the attachment point in the back electrode of the torch, especially when operating on nitrogen or air. Electrode material is vaporized and introduced into the torch gas flow. This material is excited and emits a particular spectral signature- when it exits the torch nozzle. This signature provides specific information on the erosion occurring within the back electrode. As the electrode is a Cu alloy, initial erosion studies focused on copper atomic emissions from the plasma.

Figure 1. DIAL's PT-50 dc plasma torch.



However, it soon became apparent that monitoring copper spectral emissions was of limited use in terms of developing a control monitor. While the Cu emission intensity is an indicator of electrode wear, it is impossible to determine where within the back electrode the wear is occurring, that is, whether or not the wear is localized at one point or spread over the entire electrode surface. To overcome this limitation, we developed torch electrodes that are doped at a given depth with an indicator material. When the electrode erodes through to this material the emission spectra from the arc signals the need to schedule the replacement of the torch electrode.

Figure 2 shows spectral emission over the 510 to 522-nm region from the torch before and after the arc eroded the electrode down to the indicator (silver) layer. Initially, only the three Cu spectral lines are observable. However, once the arc erodes into the doped layer an additional Ag I spectral line is clearly evident. For such an arrangement to be useful as a control monitor in torch operations, it is necessary that the change

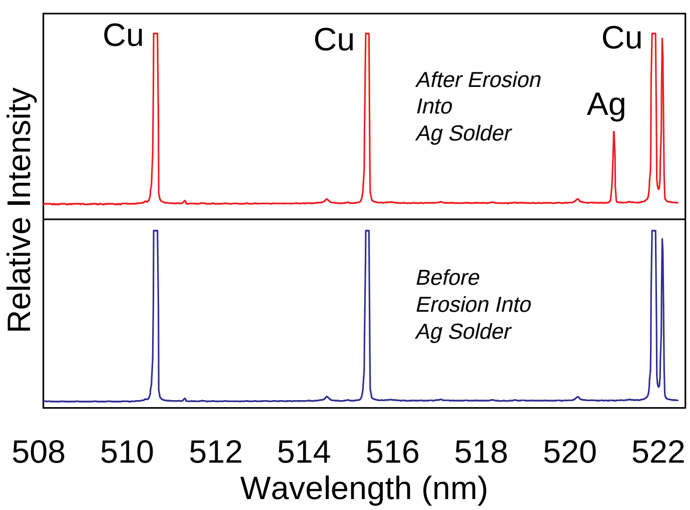


Figure 2. The emission spectra in the 510 to 522-nm region before (bottom) and after (top) the electrode has eroded into the doped region of the back electrode of the dc arc.

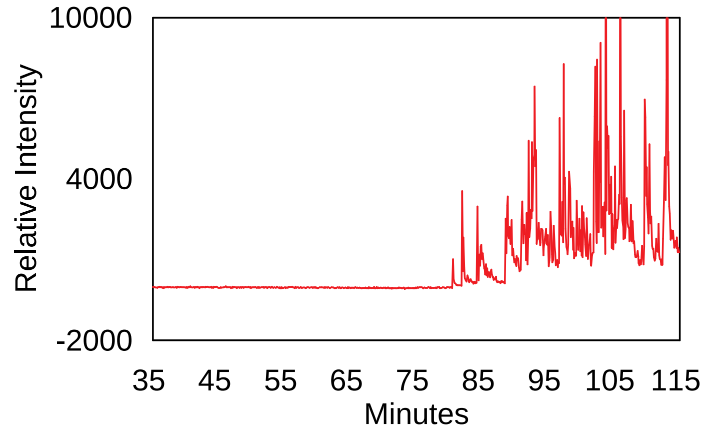


Figure 3. The variation in the intensity of the 520.9-nm Ag I spectral line with time.

in spectral emission be clear and definitive. Figure 3 clearly demonstrates an abrupt and unambiguous onset of the Ag signal. This signal was observed for over thirty minutes.

It was demonstrated that the electrode health in dc plasma torch systems can be monitored on a real-time basis. This was achieved by doping the electrode material, at a known depth from the inner surface of the back electrode, with a suitable material. In this example, we used silver as the doping material. Other materials are presently being evaluated.

Additional information about this technique can be obtained by contacting Dr. John Plodinec at:

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