Title: Optical investigation of the behaviour of the electric arc and the metal transfer during vacuum remelting of a Ti alloy

Author: P. Chapelle C. Noël A. Risacher J. Jourdan A. Jardy J. Jourdan

PII: S0924-0136(14)00156-3
DOI: http://dx.doi.org/doi:10.1016/j.jmatprotec.2014.04.024
Reference: PROTEC 13976

To appear in: *Journal of Materials Processing Technology*

Received date: 17-2-2014
Revised date: 18-4-2014
Accepted date: 19-4-2014

Please cite this article as: Chapelle, P., Noël, C., Risacher, A., Jourdan, J., Jardy, A., Jourdan, J.,Optical investigation of the behaviour of the electric arc and the metal transfer during vacuum remelting of a Ti alloy, *Journal of Materials Processing Technology* (2014), http://dx.doi.org/10.1016/j.jmatprotec.2014.04.024

Optical investigation of the behaviour of the electric arc and the metal transfer during vacuum remelting of a Ti alloy

P. Chapelle[1], C. Noël[1], A. Risacher[1], J. Jourdan[1], A. Jardy[1], J. Jourdan[2]

[1]*Institut Jean Lamour - UMR 7198 CNRS/Université de Lorraine, Laboratory of Excellence DAMAS*
Parc de Saurupt - CS 50840, 54011 Nancy Cedex, France
[2]*Timet Savoie, Avenue Paul Girod, 73400 Ugine, France*

Corresponding author: P. Chapelle, Tel: +33 383 58 42 63, Fax: +33 383 58 40 56, E-mail address: pierre.chapelle@univ-lorraine.fr

Abstract

High-speed camera imaging and optical emission spectroscopy have been used for investigating the structure of the electric arc and the transfer mechanisms of the liquid metal during Vacuum Arc Remelting (VAR) of Ti alloys. The arc exhibited a similar operating regime to that described in the previous literature for the case of Inconel 718 and zirconium alloy electrodes. The arc behaved in a diffuse mode with many separate and rapidly moving cathode spots. Several parameters of the cathode spots, including their current, size and apparent velocity were evaluated. The application of an external axial magnetic field tended to encourage the cathode spots to locate themselves on the base of the electrode. A large density ratio of Ti^+ ions and Ti atoms in the interelectrode plasma was evaluated, suggesting that the plasma was strongly ionized. The calculated excitation temperature of Ti^+ ions (1 to 1.2 eV) was about 1.5 to 2 times greater than that obtained for Ti atoms. The transfer mechanisms of the drops of liquid metal might be classified into three main modes depending on the gap length: drop falling, drip short and drop erosion induced by the cathode spots. The importance of the influence of the arc on the metal transfer mechanisms was inversely related to the gap length.

Keywords: vacuum arc remelting, titanium, experimental study, electric arc, metal transfer

1. Introduction