Effect of Surface Coating around Tungsten Electrode on Formation of "Rim"†

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KEY WORDS: (GTA) (GTA Welding) (Tungsten) (Oxide-Tungsten Electrode) (Refractory Metal) (Nonconsumable Electrode)

In a previous paper[1]., it is shown the introduction of oxygen into shelding gas of GTA welding has serious effect on durability of Oxide-Tungsten electrode. It promotes the growth of Tungsten dendrite which may be deposited at the periphery just behind the cathode area, and result in shaping "rim" like a brim of hat. The formation of the "rim" changes the arc configuration and causes the unstable arc.

The introduction of oxidizing gas but in small content changes the physical situation of the cathode working area associated with the formation of the rim. The deformation of cathode tip due to consumption is extremely large. In the case of very low feed of oxygen the shape of cathode tip little changes, though the rim is formed. Comparatively high feed of oxygen causes the serious deformation of cathode tip shape, besides rather large rim is formed.

Figures 1 and **2** show the time variation of cathode tip shape and formation of the rim. The material of the rim is considered to originate mainly from the electrode surface through oxidization of tungsten. Electrode diameter of the rod part and conical part just behind the rim, is greatly reduced. **Figure 3** explains the relationship between the electrode consumption due to oxidization and the formation of the rim. Tungsten is very easy to oxidize and its products like WO_3 can sublimate and decompose with comparatively low temperature. The vapor of oxidized tungsten may travel along the gas flow which is continuously induced into hot gas area in the neighbourhood of arc, and through decomposition pure tungsten may deposit on the surface where the situation is suitable for crystal growth.

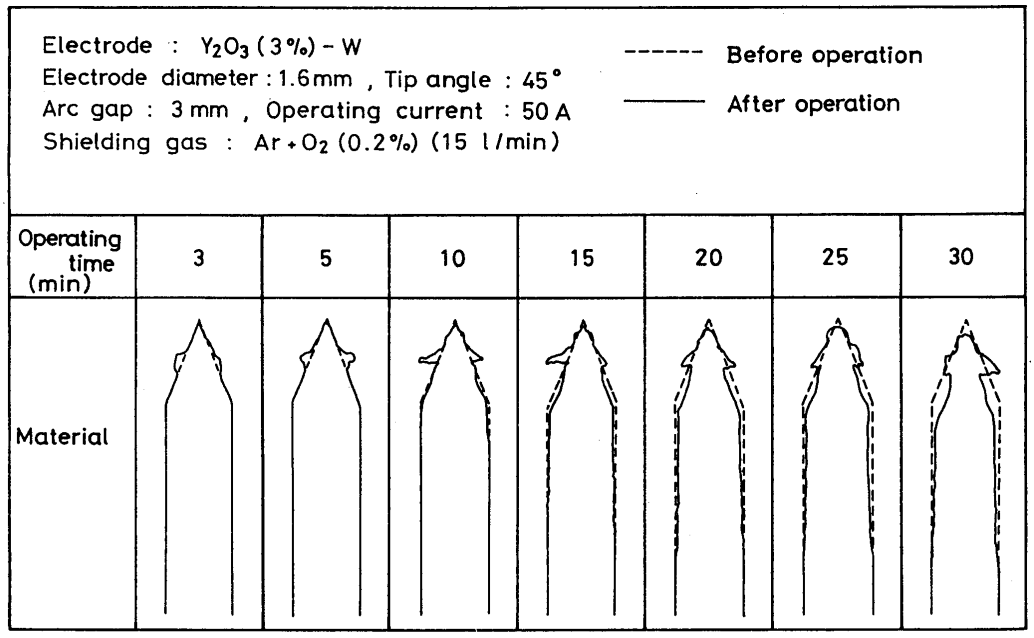

Fig. 1 Time-development of rim formation and deformation of cathode tip.

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The coating of electrode by another material with very high oxidation resistance, very high melting point, or/ and very high thermal and electrical conductivity.

A tungsten electrode which has a composit structure, such as, Copper-clad La_2O_3 (2%)-W electrode was conducted and examined. The thickness of copper seath is 0.8mm and the diameter of tungsten rod is 1.6mm. The results are shown in **Fig. 4**. The experiments are carried out in two cases of extension length. Despite the same burning condition, the copper-clad tungsten electrode shows the formation of rather small rim. And also in case of short extension length, the rim is smaller than that in long case. This is considered due to the decrease in generation of tungsten oxide. The coating of tungsten surface and decrease in surface area exposed by oxidizing gas by short extension have played similar role for reducing the volume of rim.

The copper is molten a little in the neighbourhood of cathode area. This suggests one of the conditions which should be considered to select the coating material and structure.

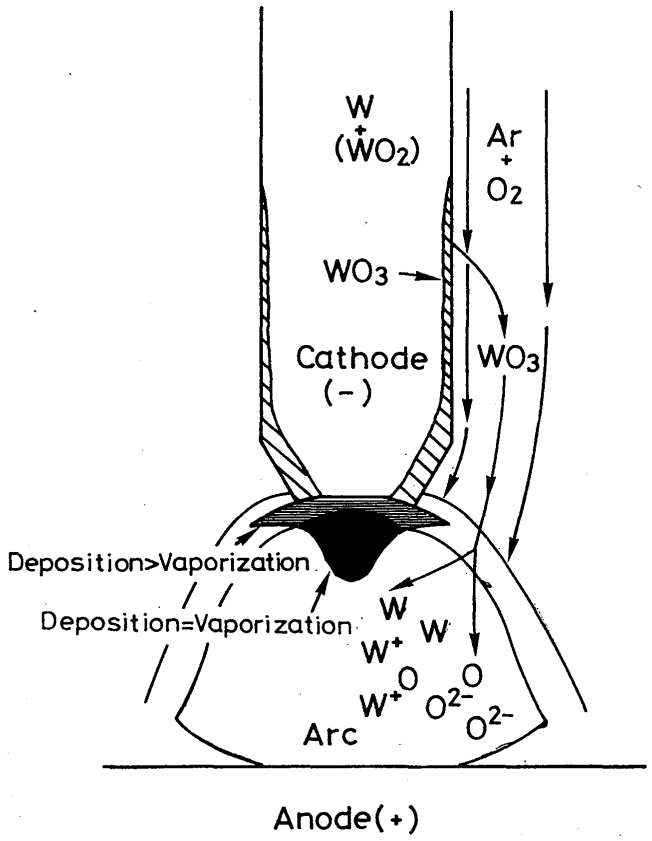

Fig. 3 Schematic illustration of rim formation mechanism.

References

1) F. MATSUDA, M. USHIO and T. KUMAGAI, Trans. JWRI, Vol. 15 (1986), p. 13.

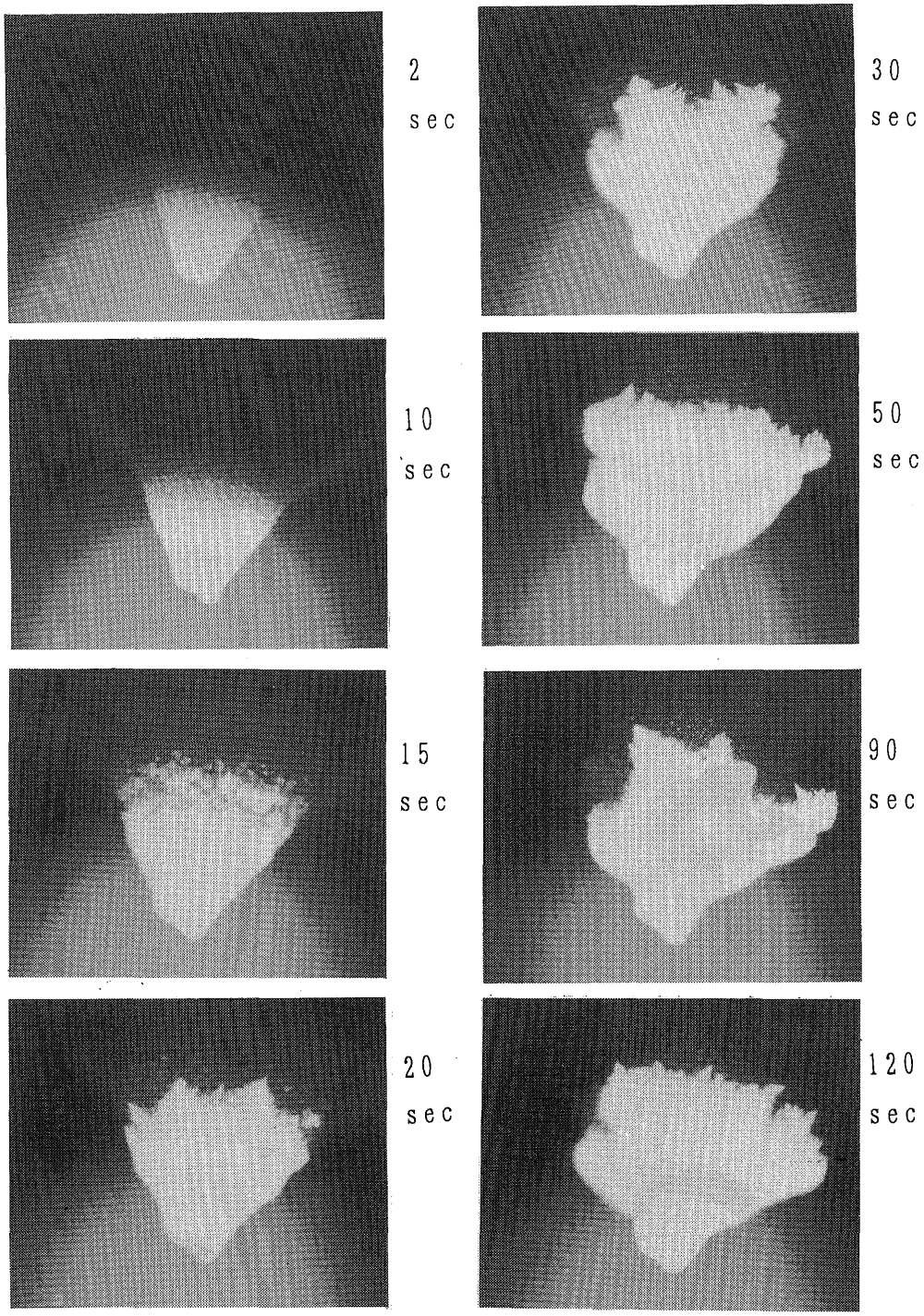

Fig. 2 Time-variation of electrode consumption and generation of rim due to arc burning in Ar-O_2 mixture gas.

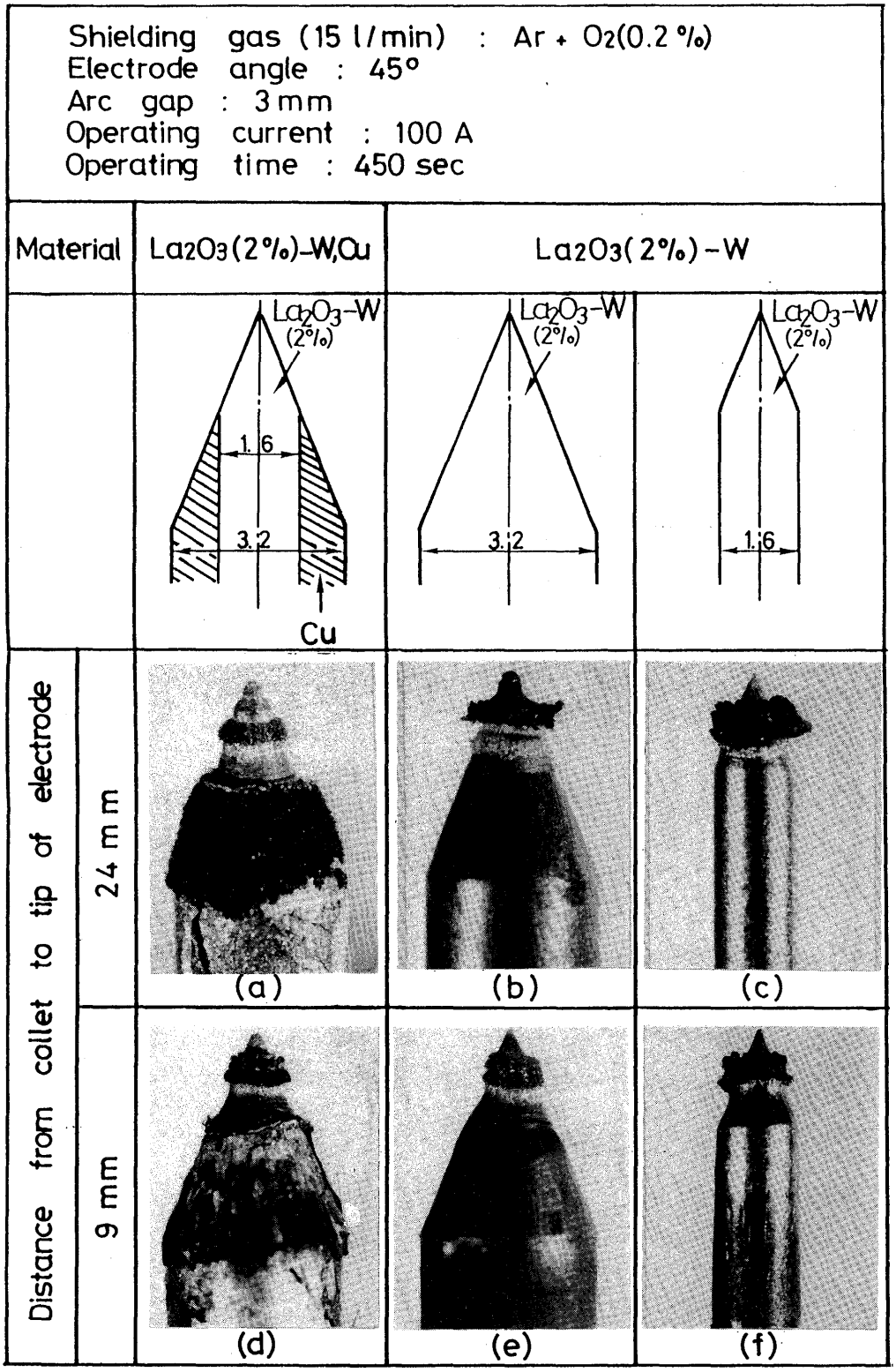

Fig. 4 Change in shape of the rim in cases of Copper-clad tungsten electrode and variable extension length.