# *The effect of working distances on the formation of TiC composite surface hardening using TIG melting technique*

A.N MD IDRISS[1], M.A. MALEQUE[1] AND A. AFIQ[2]

1Department of Manufacturing and Material Engineering, InternationalIslamic University Malaysia, P.O. Box 10, 50728 Kuala Lumpur, Malaysia
[2]Materials Engineering and Testing Unit Research Bhd, Kajang, Selangor

# *Introduction - pg. 1*

- Surface modification is a technique to harden the substrate layer via the incorporation of reinforcing material serving the purpose of increase of wear resistance

Available known  surface modification technique

Lasers

Electron beam

TIG

- Expensive
- High skill operator to operate
- Complicate process
- Time consuming

- Cheap
- Semi or low skill  to operate
- Easy to handle
- Not time consuming

# *Introduction – pg. 2*

- Factors that influences melt pool sizes and microstructural features, defects and hardness

Voltage

Current

Speed

Shielding gasses

Reinforcing content

Fluxes

Preheating / post heating

WORKING DISTANCE / ARC LENGTH

The effect of WD on the formation of the TiC MMC layer is yet to be uncovered

# *Introduction – pg. 3*

SUBSTRATE MATERIAL

- AISI 4340 low alloy steel
- Low hardness (300 HV)
- Easily deteriorates under wear
- Easily deteriorates under high temperature wear
- Requires hardening.

Reinforcing particulates

- TiC (3000 HV)
- Good wettability
- Low density
- Low thermal conductivity
- Compatible to steel
- High melting temperature

Substrate surface with TiC particulates under TIG arc may increase the hardness thus prolonging hour service of the altered layer

By just altering the working distances involving no cost, modification of metals are abled to be tailored, instead of adding more heat input, shielding gasses, fluxes, or preheating/postheating acquiring cost.

# Introduction – pg. 4

- The objective of this work is to investigate the microstructural features and the microhardness behaviour of the produced TiC MMC at 0.5 mm and 1.5 mm working distances of 1344 J/mm heat input
- Results pertaining to the surface morphology, microstructures, defects and microhardness are compared and presented

# Experimental work - pg 5

**MATERIAL**

- TiC with the size from 45 to 100 micron
- Low alloy steel substrate, 100 x 40 x 14 mm

**SAMPLE PREPARATION**

- TiC added with PVA binder and preplaced on substrate surface (hand lay up)
- Sample dried in the oven to remove moisture at 80C
- Melted under TiG arc at 1344 J/mm of 0.5 mm and 1.5 mm working distances
- Sample halved and etched using nital solution for revealing the microstructural features
- JEOL 5600, Nikon epiphot and Wilson Wolpert used for determining the microstructures, defect and topography, melt dimensions and microhardness respectively

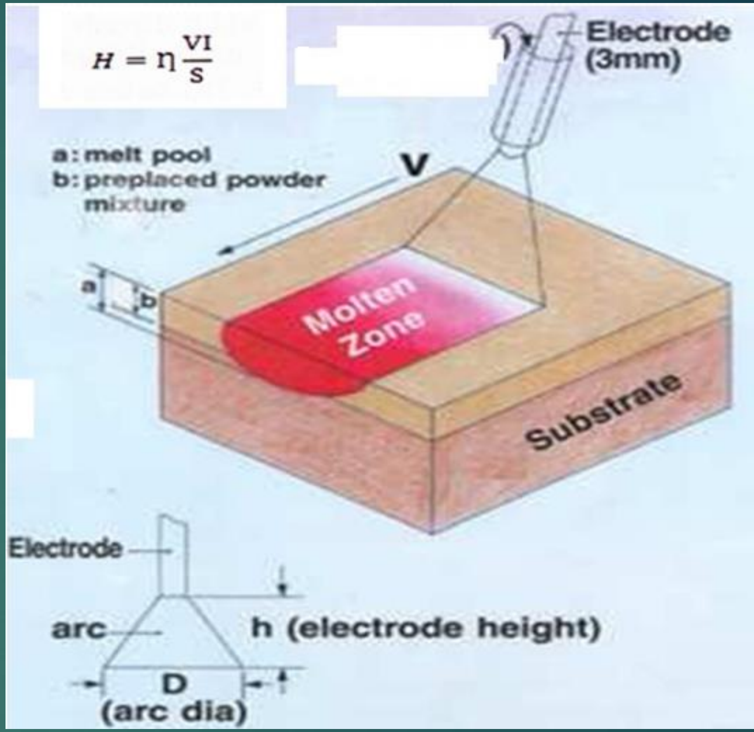



Illustration describing the TIG melting of preplaced particulates on substrate

# Results and Discussions - pg. 6

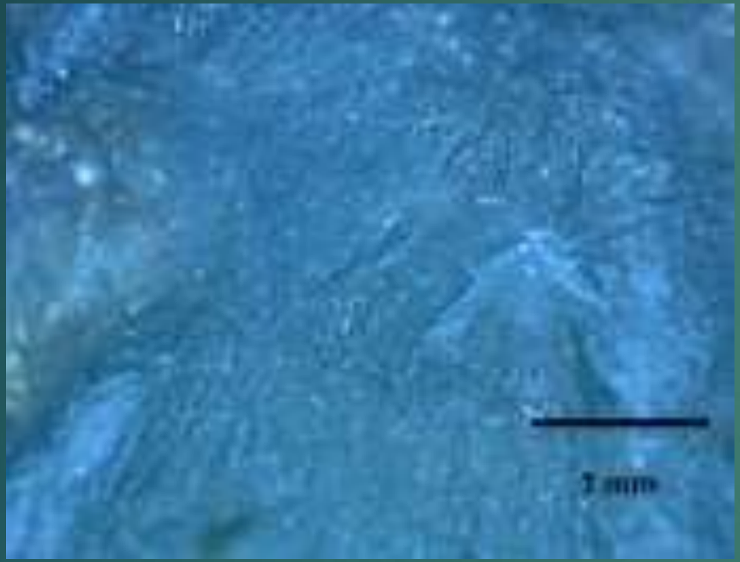
| Working distances | Melt Depth | Melt Width | HAZ |
|---|---|---|---|
| 0.5 | 1 | 3.47 | 1 |
| 1.5 | 0.834 | 3.15 | 1.1 |

- Extending the working distance to 1.5 mm gave energy losses through the arc column. Less heat intensity to form melt pool
- Short working distance - heat intensified and resulted large melt sizes

# Results and Discussions - pg. 7

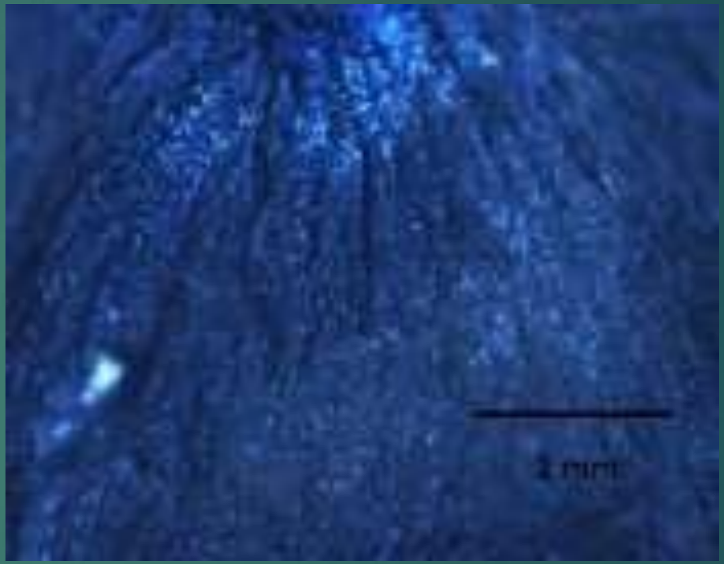
## SURFACE TOPOGRAPHY

1.5 mm working distance



Sudden solidification, viscous melt gave flat surface with edges that are rough

0.5 mm working distance

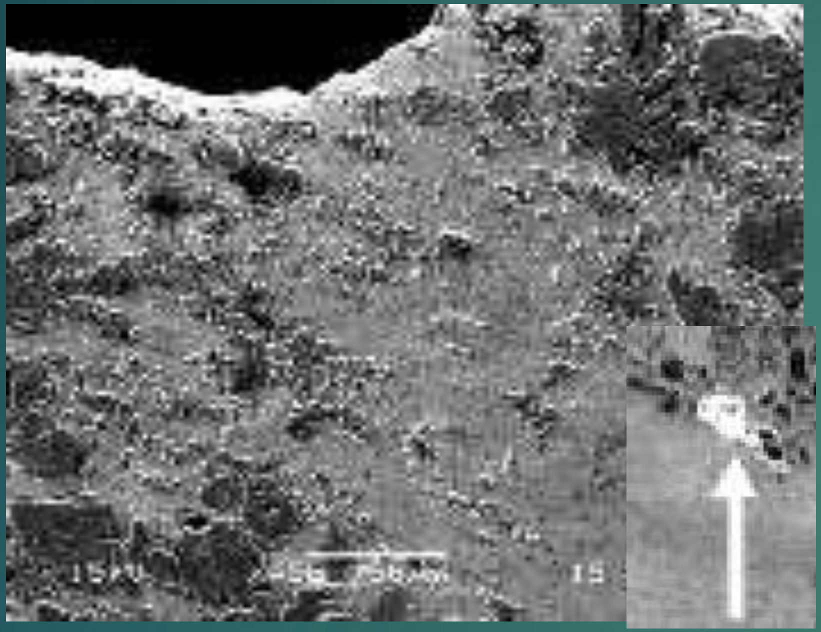


Less viscous from stirring action in the melt resulted ripples on the solidified surface.

# Results and Discussions - pg. 8

**Microstructural feature and defects**

1.5 mm working distance



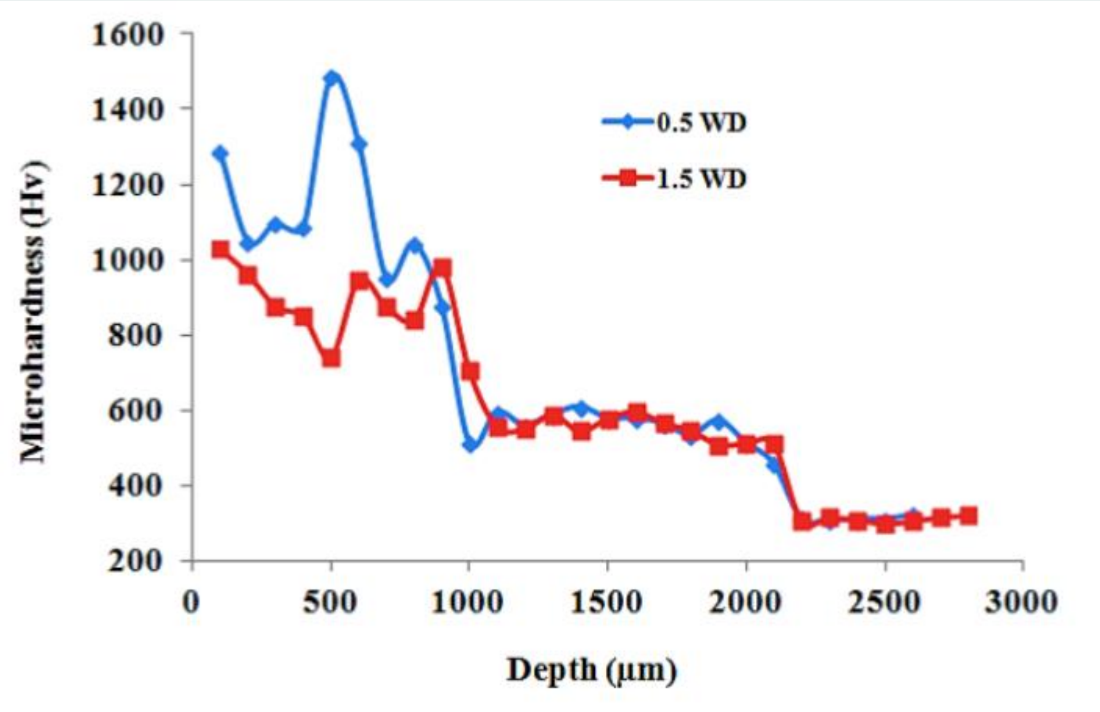
Poor dissolution with more matrix domination and less retained undissolved carbide

0.5 mm working distance

More particulates dissolution, cubic, globular and dendritic

# Results and Discussions - pg. 9

**MICROHARDNESS**




Overwhelmed reprecipitation near the arc source gave hardness between 1000HV to 1500 HV with 0.5 mm working distance

Matrix domination than carbide resulted low hardness between 700 HV to 1000HV

# *Conclusions - pg. 10*

- 1. Coated tracks fused at 1344 J/mm of 0.5 mm and 1.5 mm working distances were successfully produced to consolidate TiC particulates on the AISI 4340 low alloy steel substrate.
- 2. Samples were crack free
- 3. Energy losses via extending the arc column resulted less heat intensity as the width broadened and so they retained more undissolved TiC particulates
- 4. Reprecipitation masses of carbide encouraged hardness seeing majority depth over than 1000 HV.
- By manipulating the simple working distances, variety of melt properties are able to be tailored instead of heat input, shielding difference of gasses, preheating/post heating or adding fluxes involving cost.

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THANK YOU


5th International Conference on Mechanical,
Automotive and Aerospace Engineering 2021
22nd – 23rd June 2021
Kuala Lumpur, Malaysia