

TiC-TiB₂ Composite Coatings & Stress Wave Analysis

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OUTLINE

1

TiC-TiB₂ Composite Coatings

2

Stress Wave Analysis

3

Future Work



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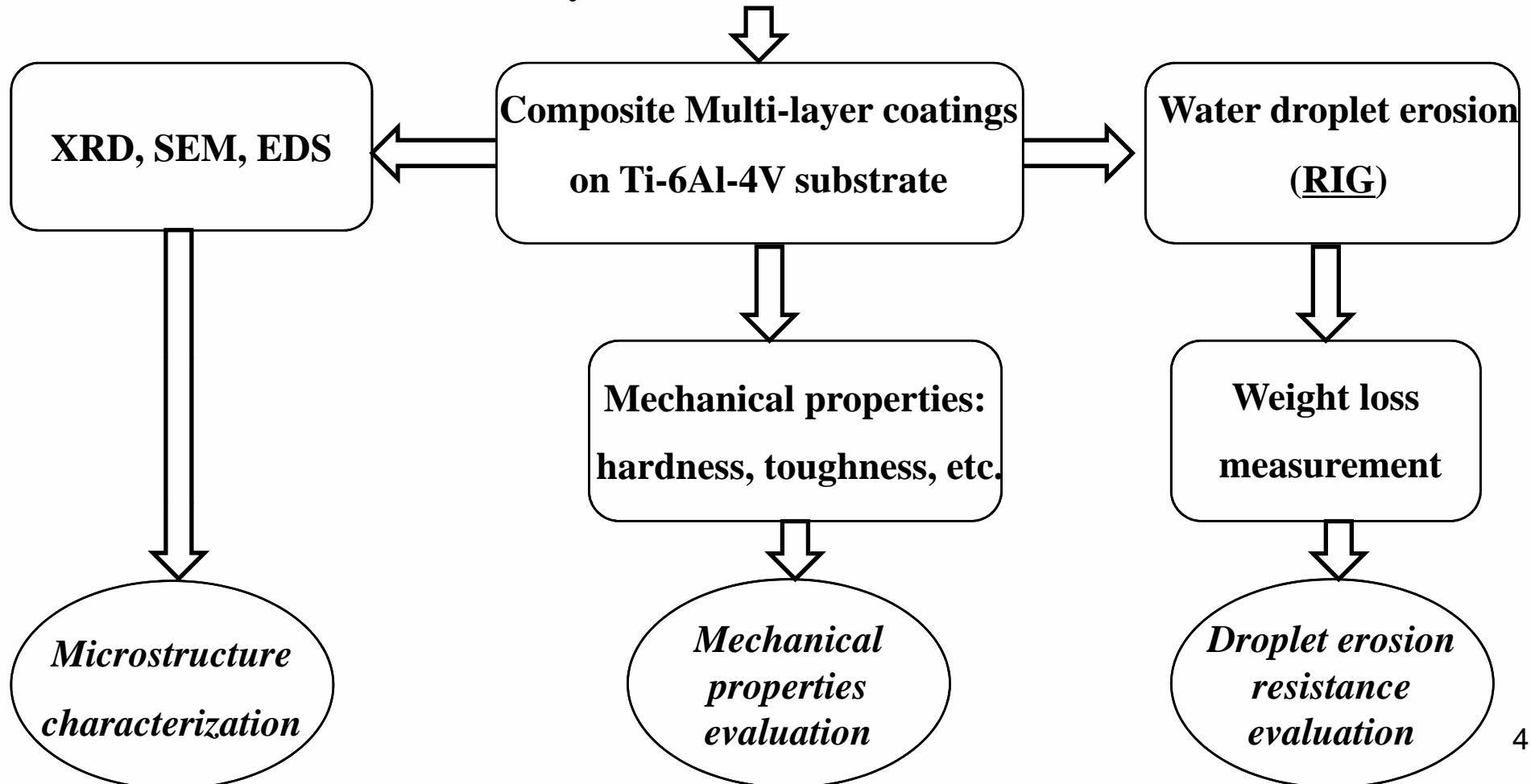
TiC-TiB₂ Composite Coatings

Fabrication of water erosion resistant coatings

➤ Composite Coatings

➤ Multiple-Layer Coatings

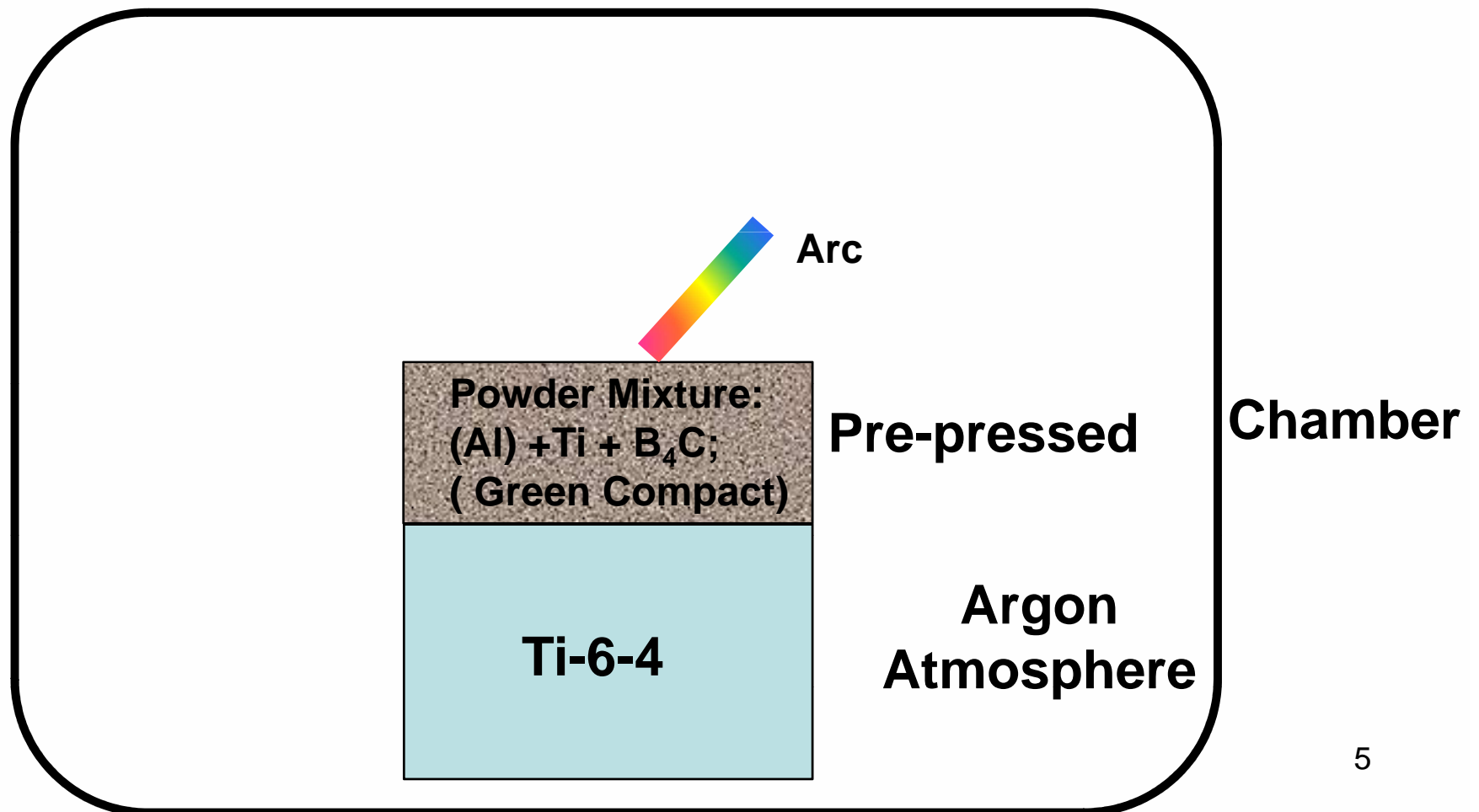
* Stress wave analysis: thickness calculation



1

TiC-TiB₂ Composite Coatings

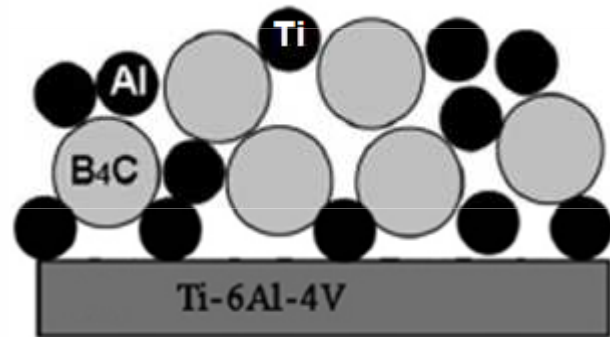
Experiment Setup



1

TiC-TiB₂ Composite Coatings

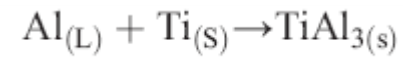
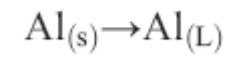
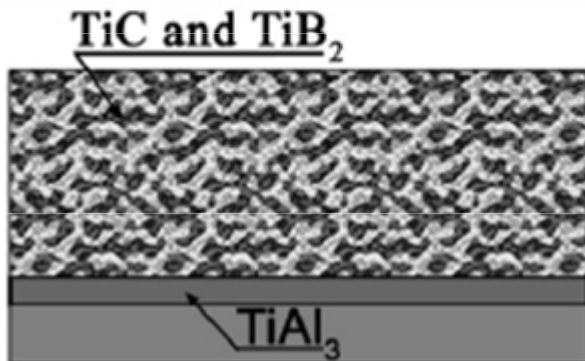
Chemical Reaction Mechanism



Heated
1100°C
30 min



**Arc
Melting**



1

TiC-TiB₂ Composite Coatings

Composition of Powders

	Weight Percentage %		
	Al	B ₄ C	Ti
A	0	28	72
B	57	12	31
C	73	8	19
D	80	6	14
E	70	6	24
F	77	4	19

1

TiC-TiB₂ Composite Coatings

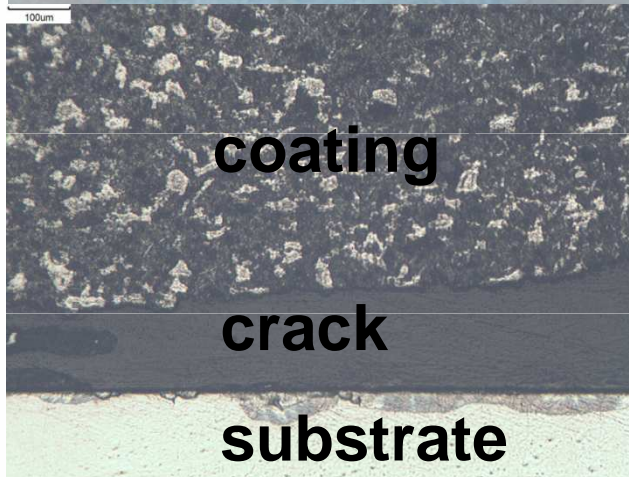


Powder Mixture:
(Al) + Ti + B₄C;
(Green Compact)

Ti-6-4



A (0% Al)



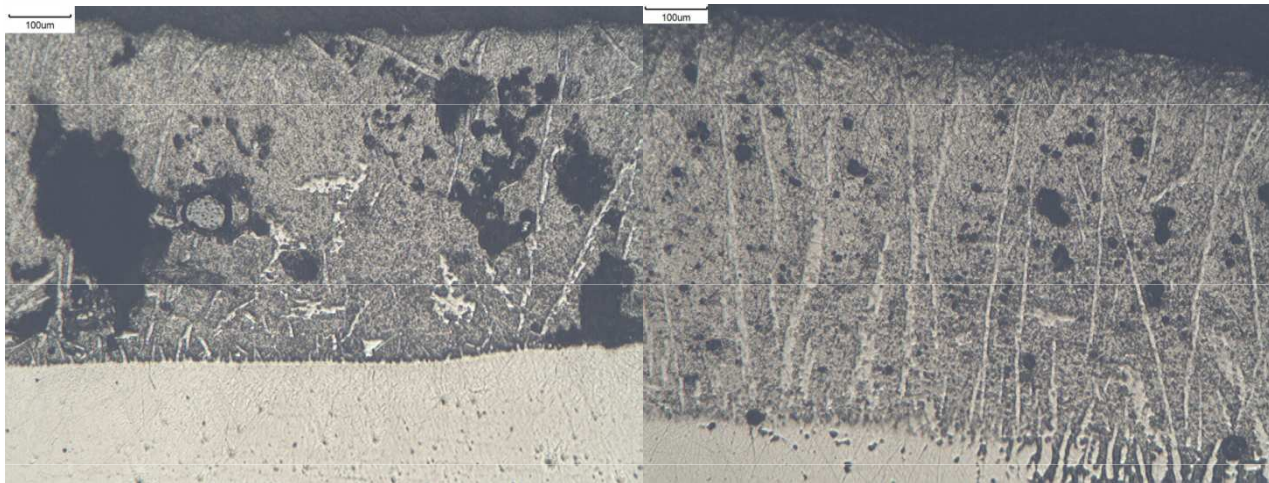
C (73% Al)

1

TiC-TiB₂ Composite Coatings

Porosities

Composition C (%wt):
73Al-8B₄C-19Ti



31MPa

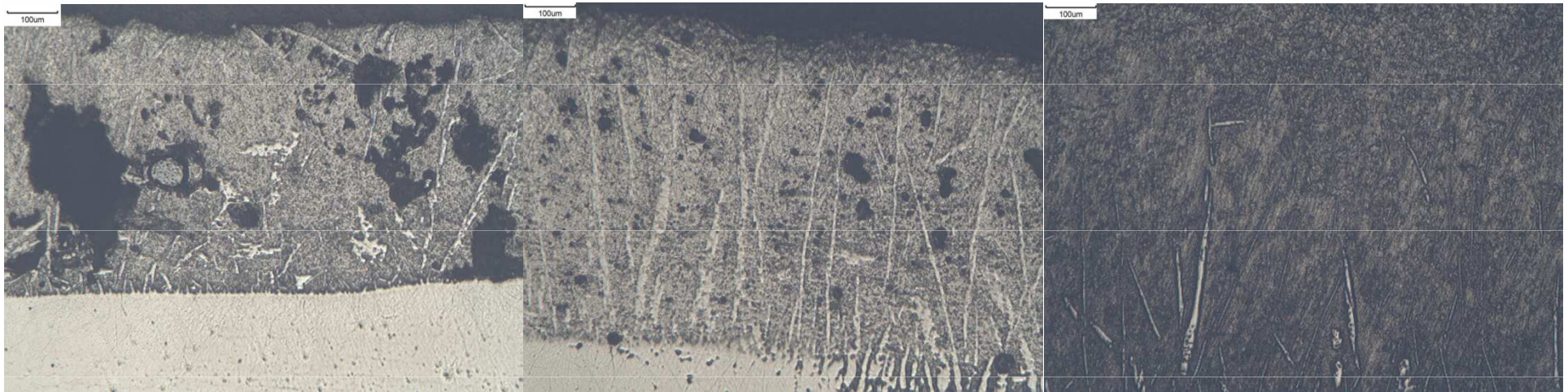
98MPa

1

TiC-TiB₂ Composite Coatings

Porosities

Composition C (%wt):
73Al-8B₄C-19Ti



31MPa

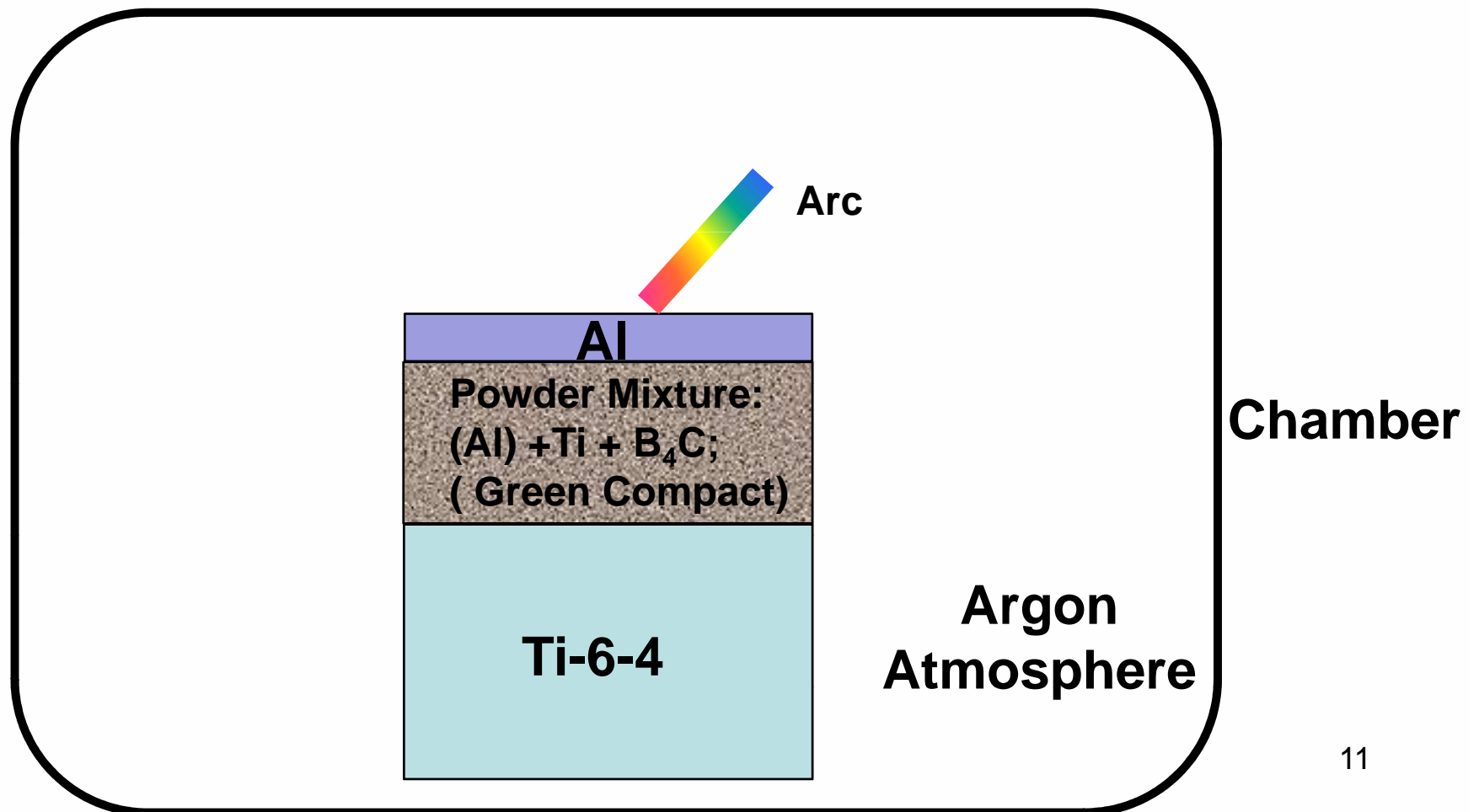
98MPa

40MPa
with Al cover

1

TiC-TiB₂ Composite Coatings

Modified Experiment Setup

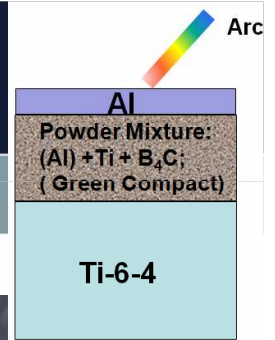
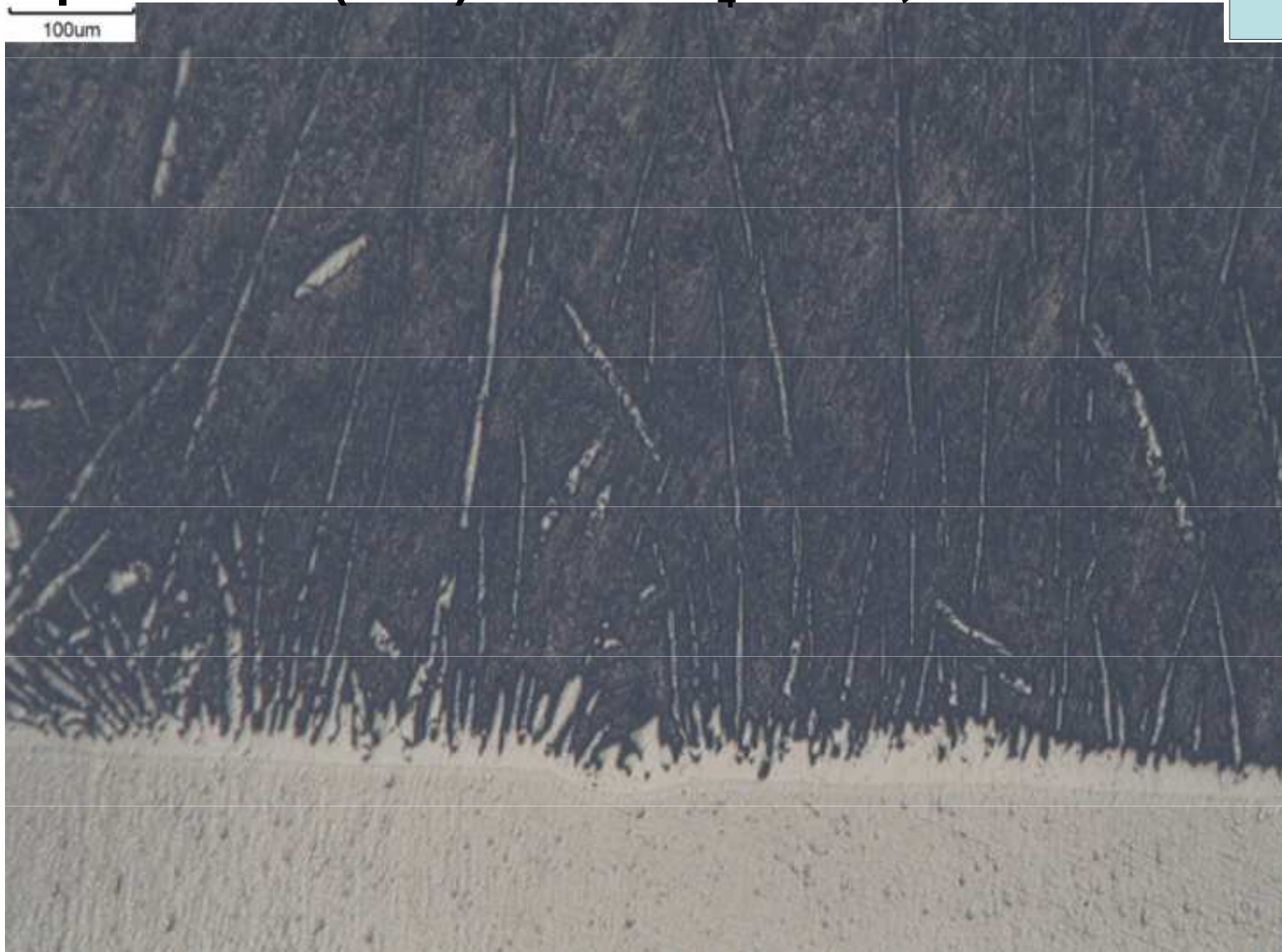


1

TiC-TiB₂ Composite Coatings

Bonding: Diffusion layer

Composition C (%wt): 73Al-8B₄C-19Ti, 40MPa

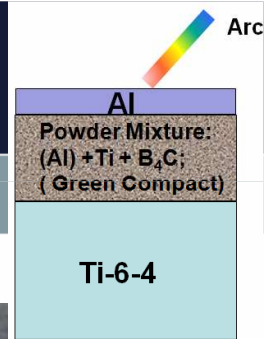


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TiC-TiB₂ Composite Coatings

Bonding: Diffusion layer

Composition C (%wt): 73Al-8B₄C-19Ti, 40MPa





2

Stress Wave Analysis

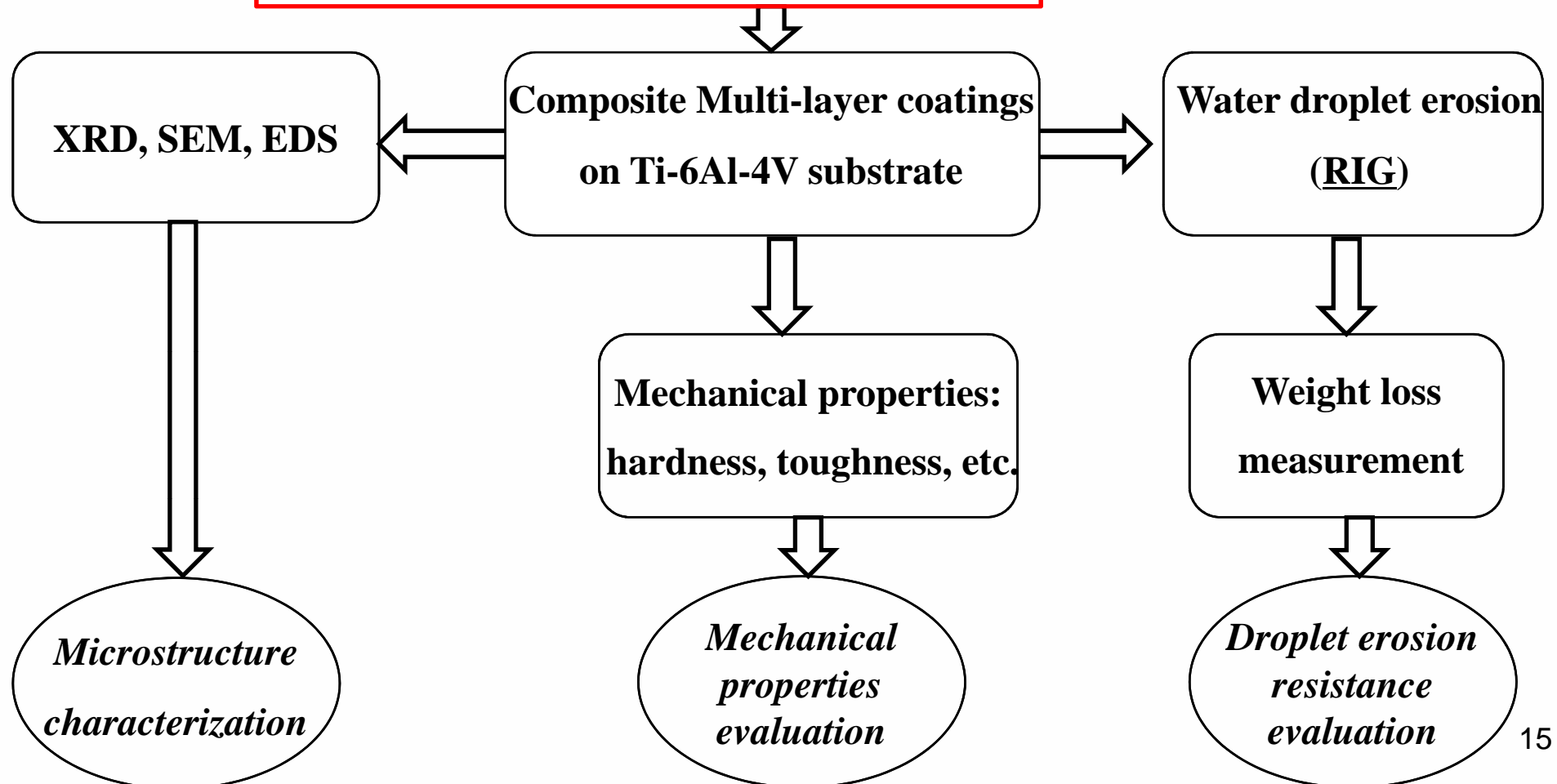
- *From Rectangle Wave to Triangle Wave*

- *From Rectangle Wave to Triangle Wave*

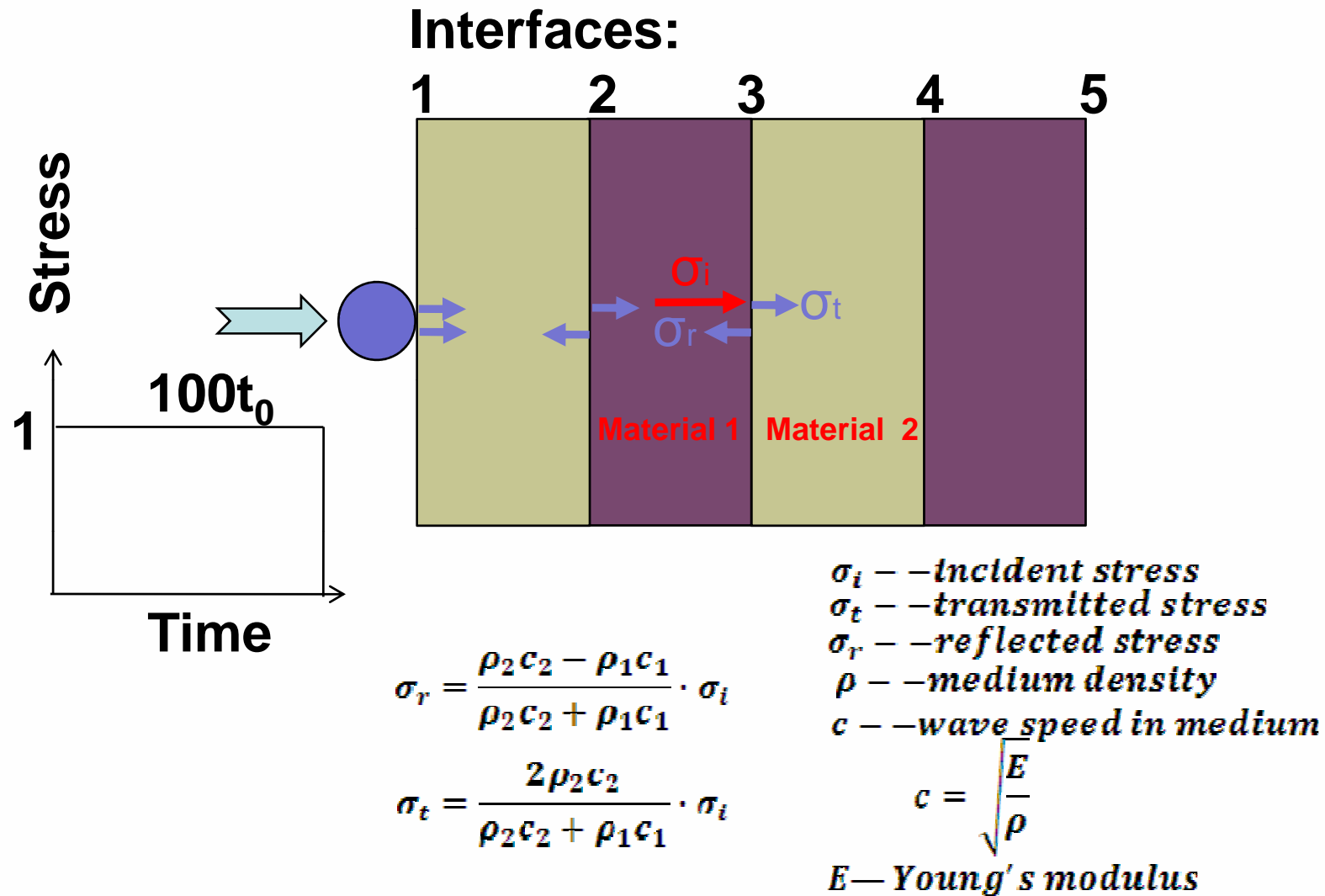
Fabrication of water erosion resistant coatings

- **Composite Coatings**
- **Multiple-Layer Coatings**

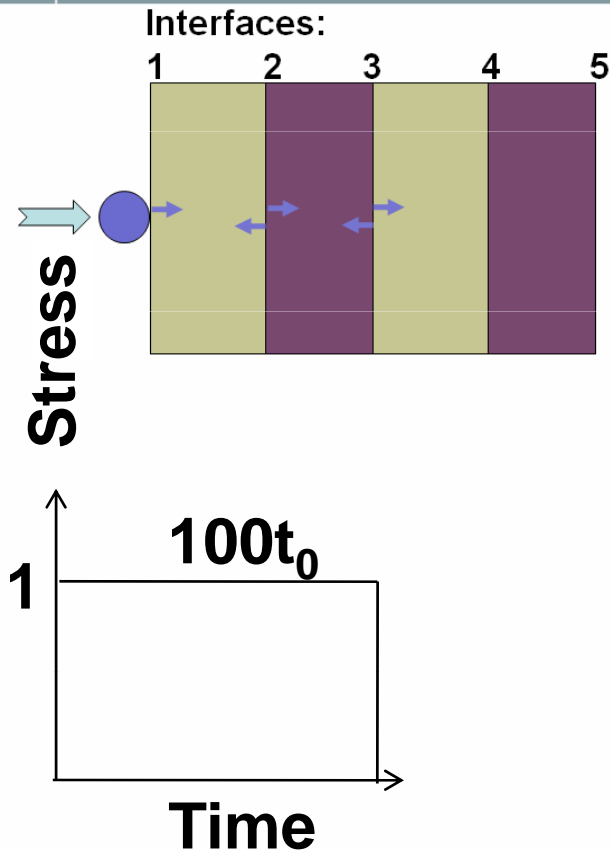
* **Stress wave analysis: thickness calculation**



Background: Simplifications



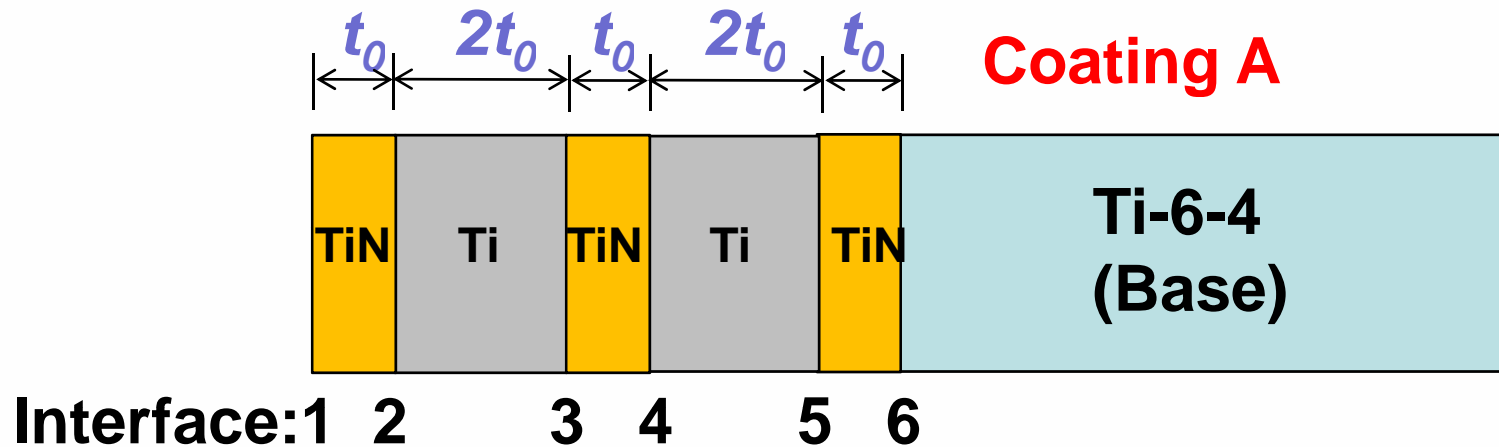
Background: Simplifications

**Simplifications:**

1. **Single droplet**
($\Phi 16.65 \mu\text{m}$, 500m/s)
2. **Linear and rectangle wave**
3. **Incident stress = 1 unit**
4. **Incident time range = $100t_0$**
($t_0 = 3.3\text{E-}10 \text{ s}$)
5. **100 pulses**
6. **No energy loss**
7. **Thickness design** (t_0 by integer)
 $1t_0$ -----3.5 μm TiN / 1.6 μm Ti layer

Coating A

Time the wave travel through each layer

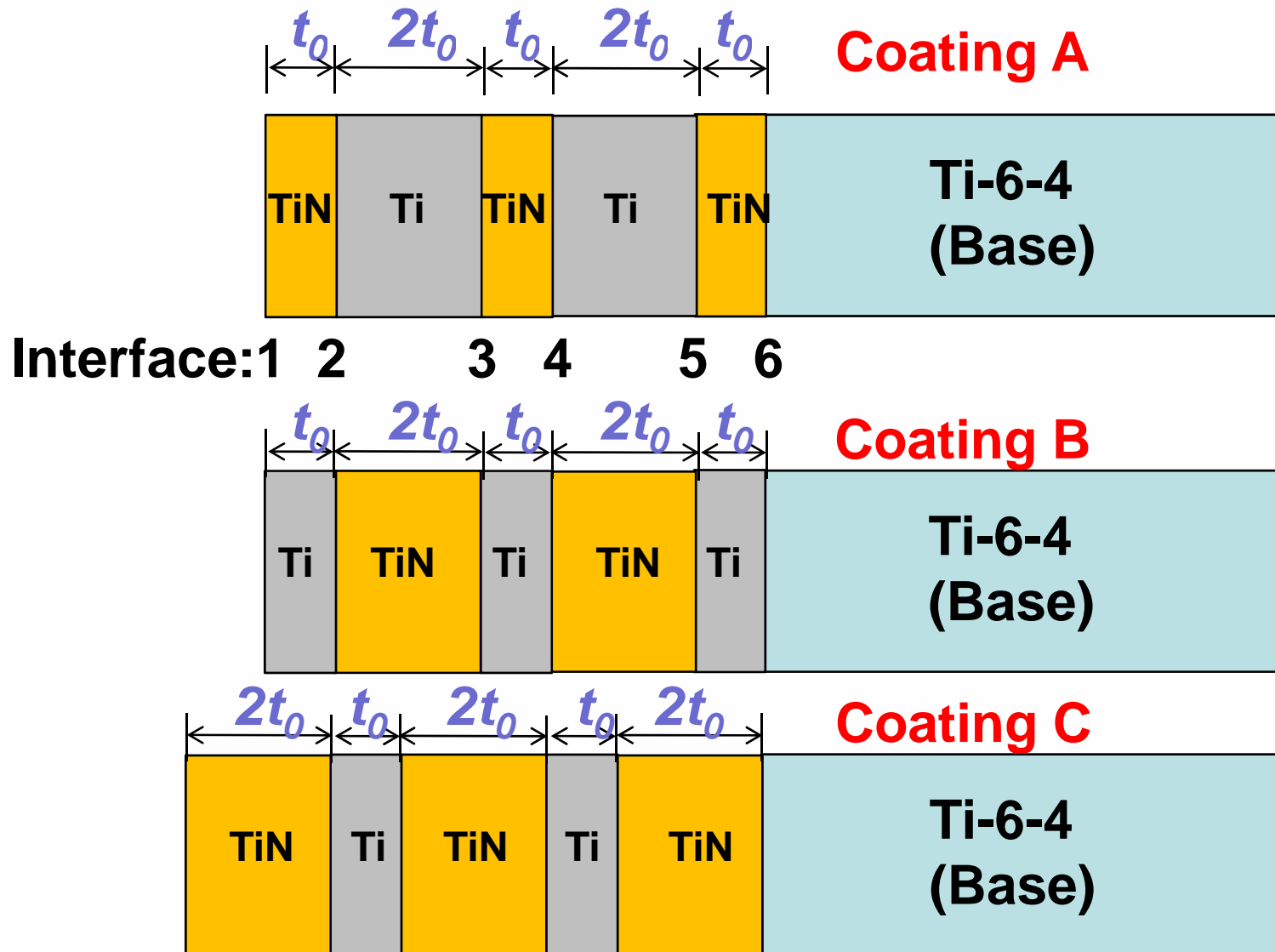


Simplifications:

8. Base metal thickness: infinite

Coating A Vs. Coating C

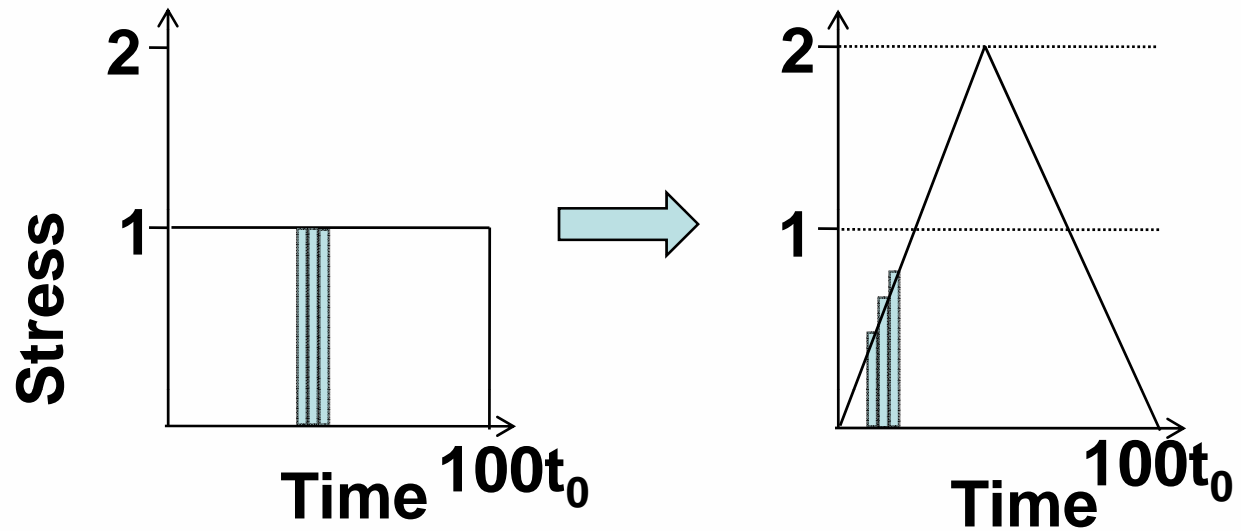
Time the wave travel through each layer



2

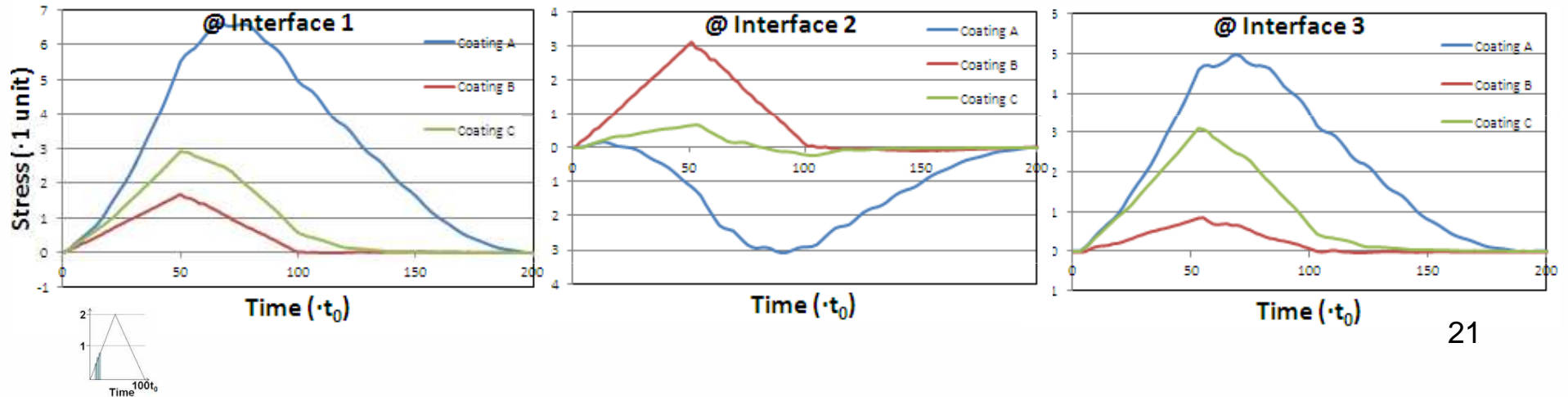
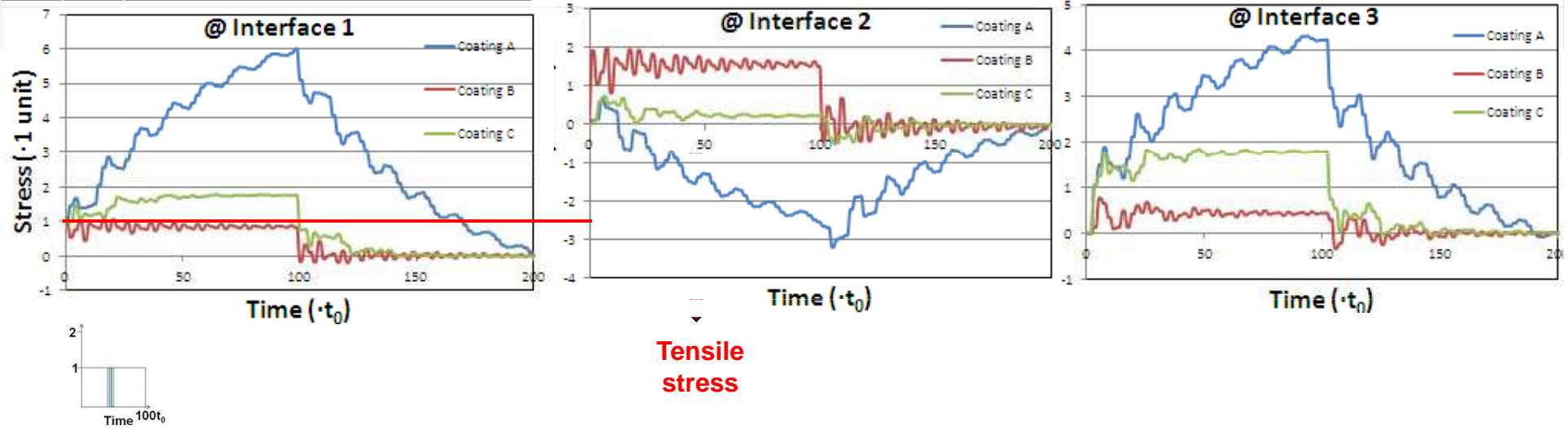
Stress Wave Analysis

Background: Simplifications



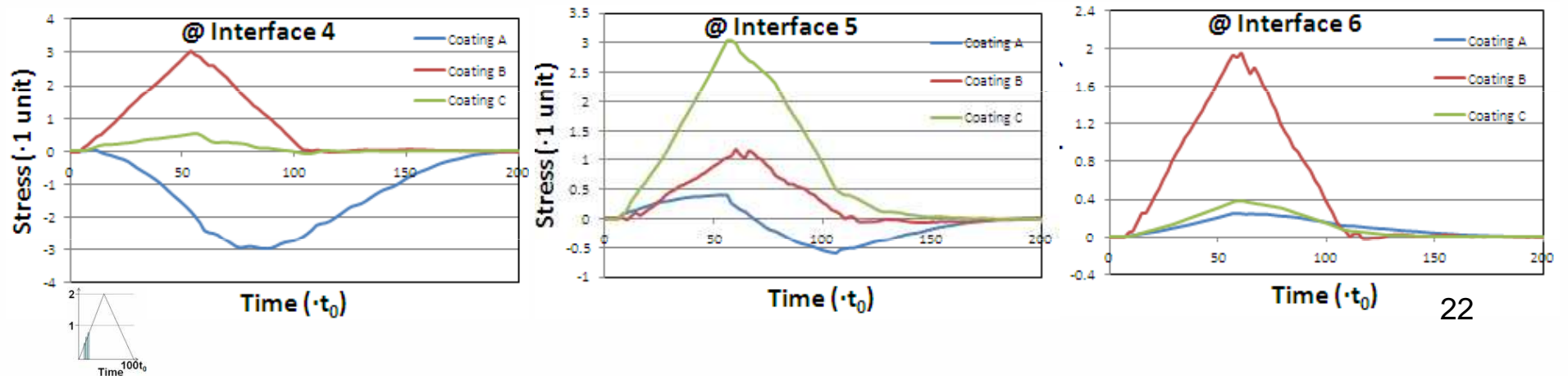
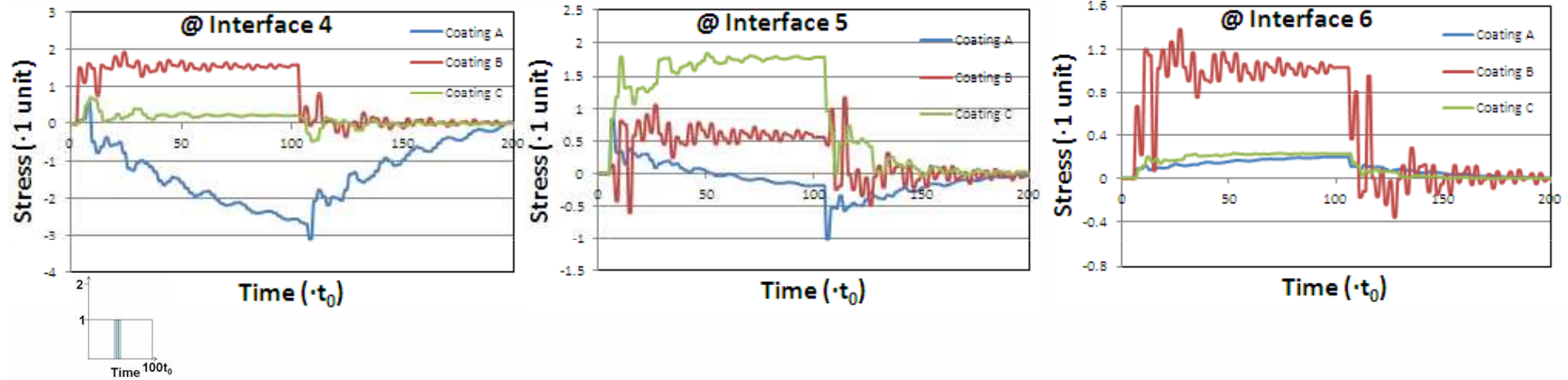
2

Stress Wave Analysis



2

Stress Wave Analysis





3 **Future Work**

TiC-TiB₂ composite coatings

- * **Further improve coating techniques**
 - **Al plate/foil**
 - **composition**

- * **Characterization**
XRD, SEM, EPMA

- * **Hardness testing**

- * **Water Erosion Test**

3

Future Work

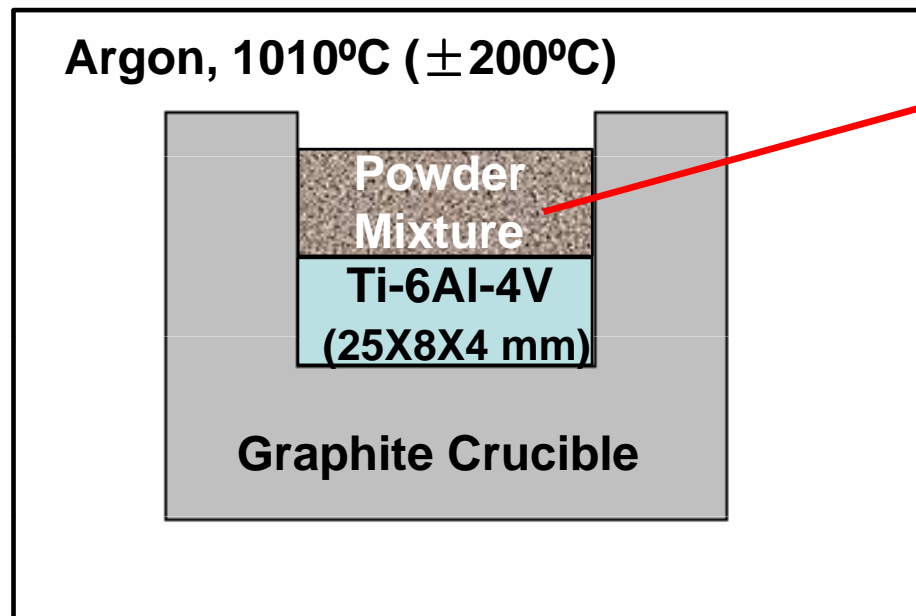
Boronizing Coatings

- * Vacuum Tubular Furnace
Downpay, & Ready to ship**

- * Boron Powders
On shipping**

Boronizing Coatings

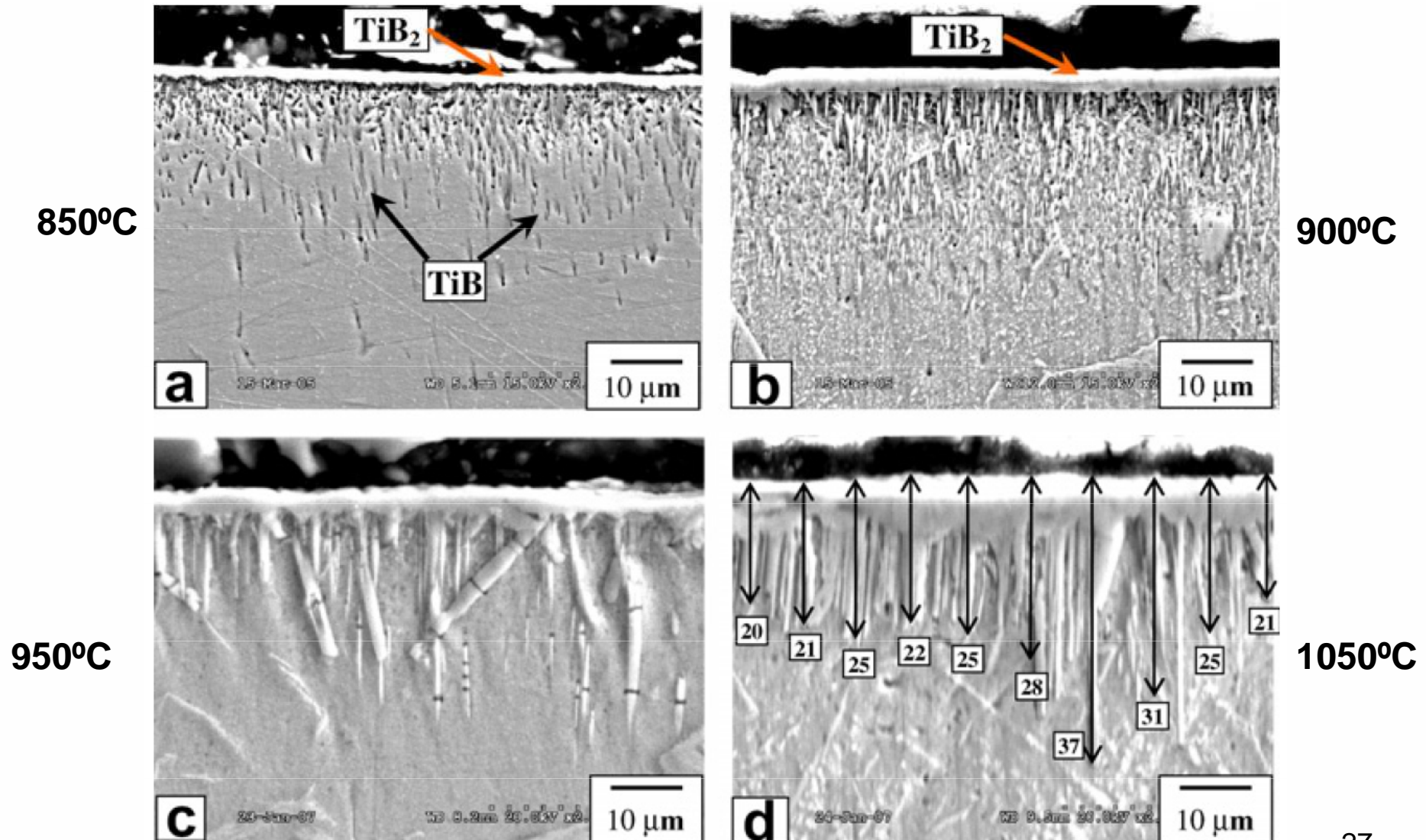
Setup Illustration

**Powder Mixture:**

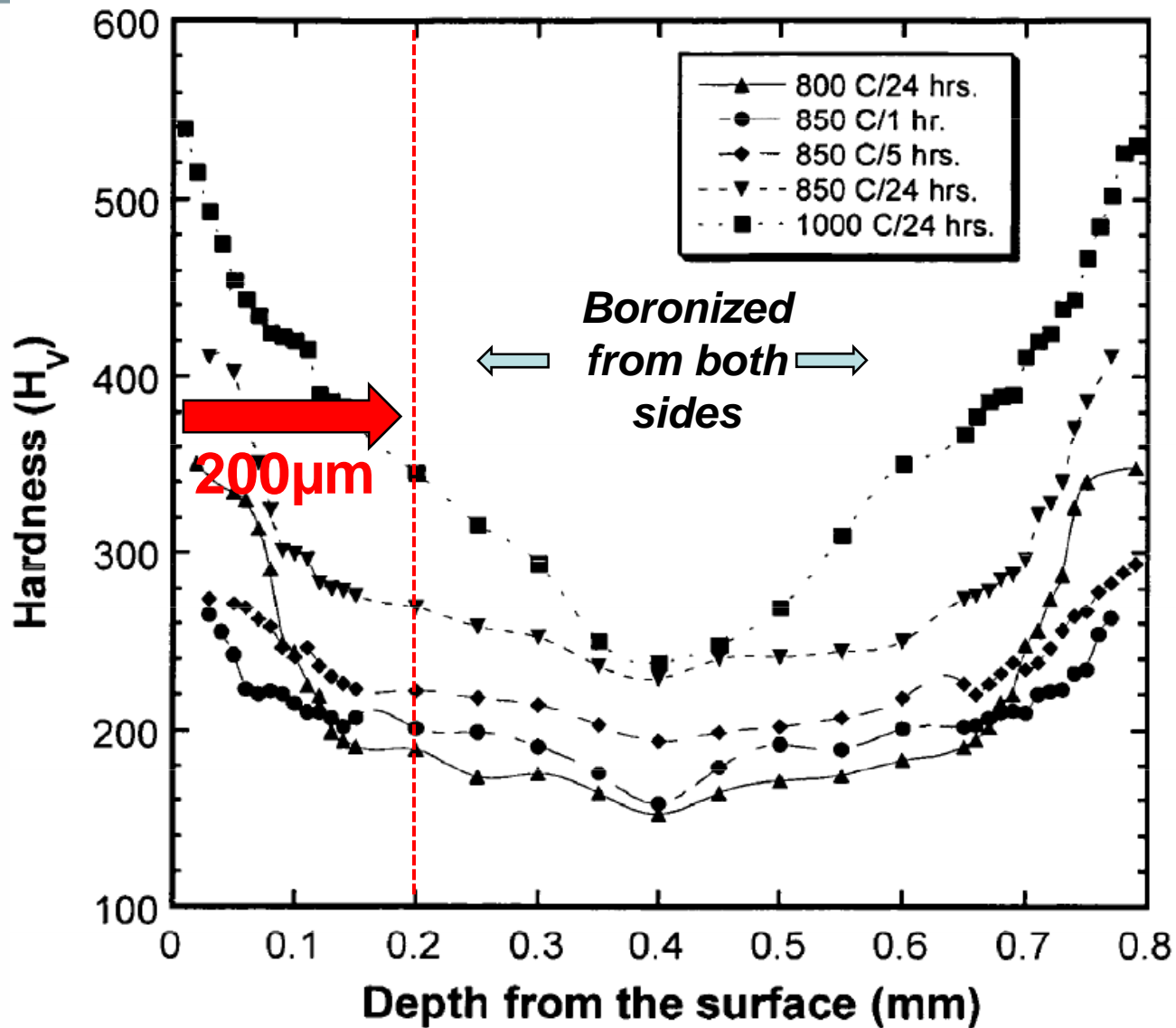
[US Patent 7264682, 2007]

- * Boron, amorphous (reactant)
- * Na_2CO_3 (activator)
- * Carbon, activated (filler material)

Boronizing Coatings



Boronizing Coatings



[US Patent 7264682, 2007]

Laser Cladding

Powders:

* TiC

* TiB₂

* TiB

* Mixture powders: Ti/Al/B₄C, TiC/TiB₂, TiB/TiB₂
(under discussion with the technician)

* Other possible tries:
WC, ZrO₂, Si₃N₄



Thank You !