**Ministry of Education and Science of Ukraine**

**National Technical University of Ukraine**

**“Igor Sikorsky Kyiv Polytechnic Institute”**

Faculty of Physical Engineering

High Temperature Materials and Powder Metallurgy Department

**BACHELOR DEGREE WORK**

on the topic :

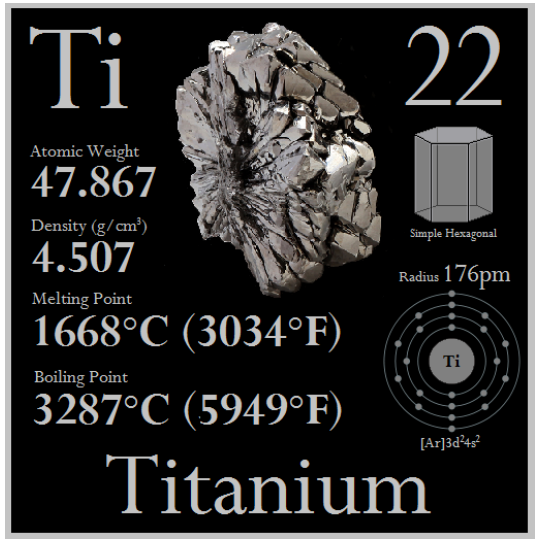
# Effect of the crystallization kinetic parameters on the microstructure, physical and mechanical properties of a eutectic alloy of the Ti-TiB system

Student of group FK-31: Elkanov R.Sh.

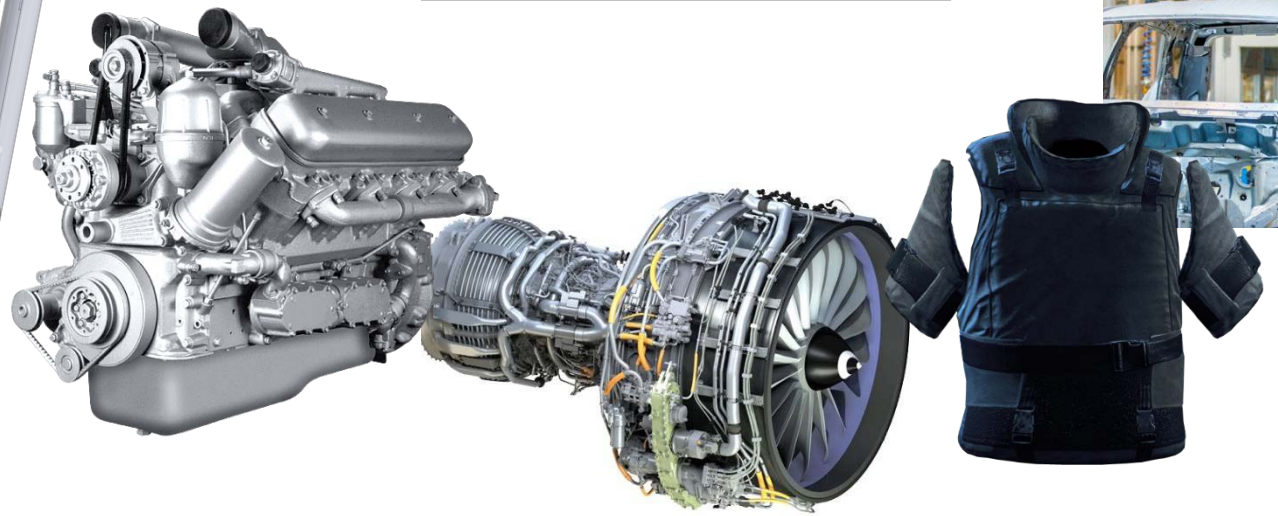
Supervisor: Prof., D.Sc.Tech., Loboda P.I.

Supervisor of technical part: asp. Remizov D.O.

# Relevance of the topic





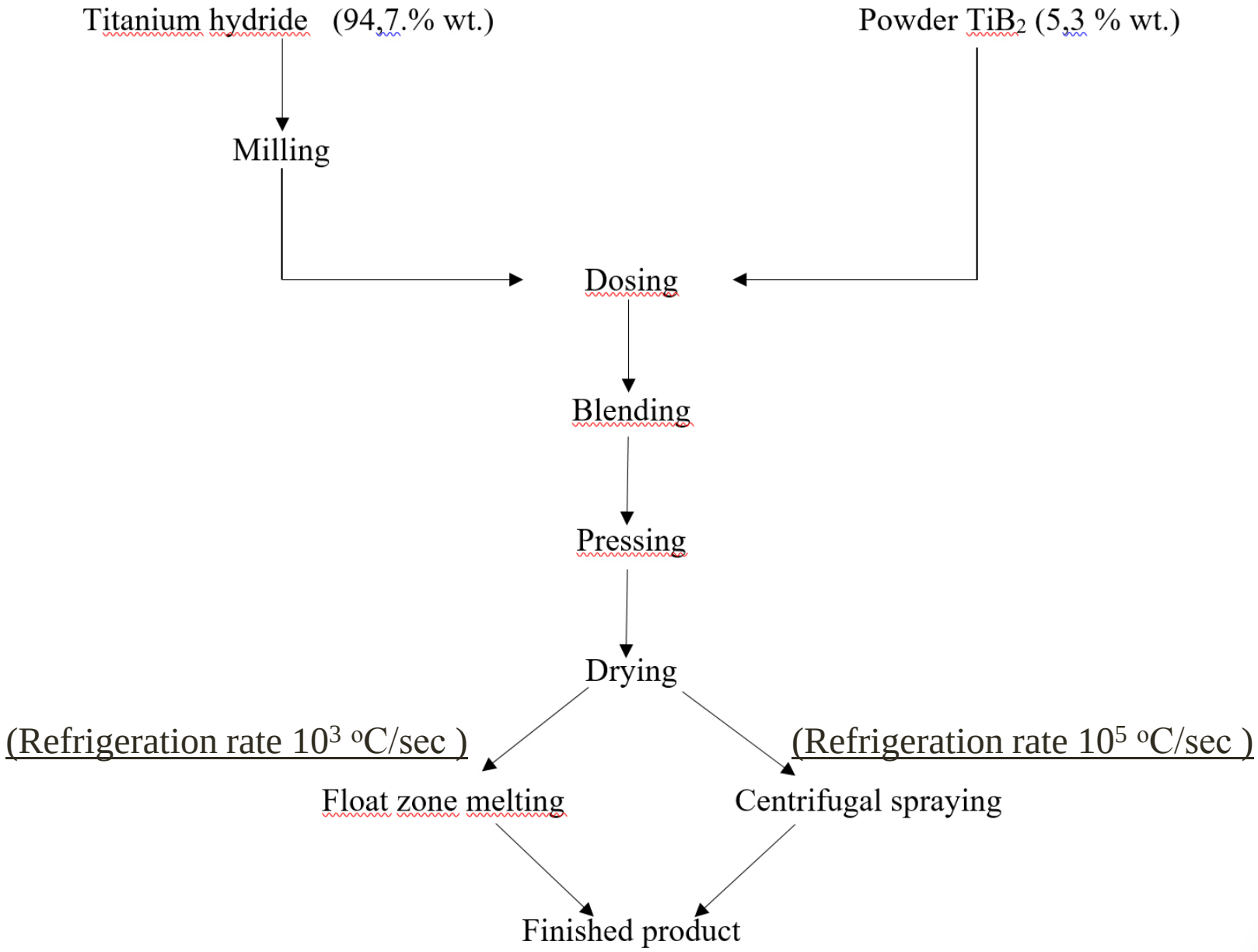


Aim of the work is to establish an effect of the crystallization kinetic parameters on the microstructure, physical and mechanical properties of a eutectic alloy of the Ti-TiB system.

# Tasks:

- To obtain Ti–TiB alloy by the method of direct crystallization in conditions of float zone melting and obtain Ti – TiB powder by mass crystallization in conditions of centrifugal spraying;
- To investigate the effect of crystallization rate of Ti – TiB eutectic alloy obtained by the method of direct crystallization in conditions of float zone melting and by mass crystallization in conditions of centrifugal spraying, on microstructure and homogeneity of phase composition;
- To study an effect of structural characteristics (quantity of boride fibers, fibers' sizes, distribution of fibers in matrix etc.) on alloy's hardness;
- To investigate the connection between physical, mechanical and structural characteristics of direct and mass crystallized Ti – TiB alloy.

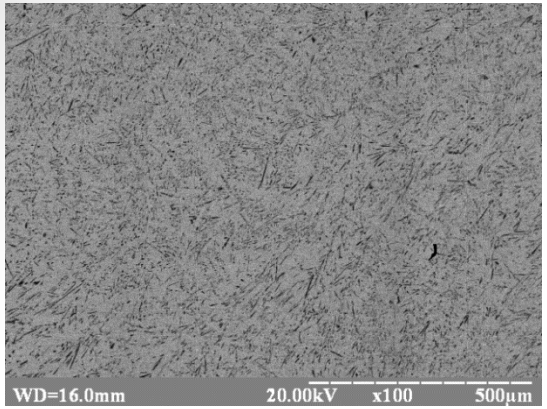
# Technological scheme of obtaining materials for investigation



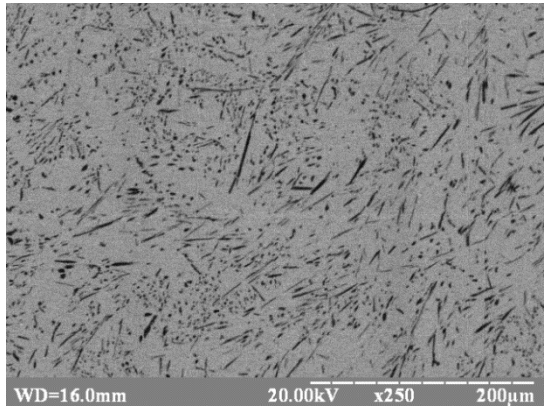
# Appearance of “Crystall 206” apparatus

# Microstructure of the alloys, obtained by direct crystallization

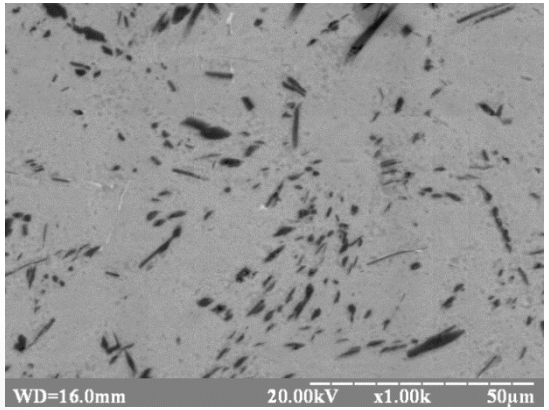
Perpendicular to the direction of crystallization



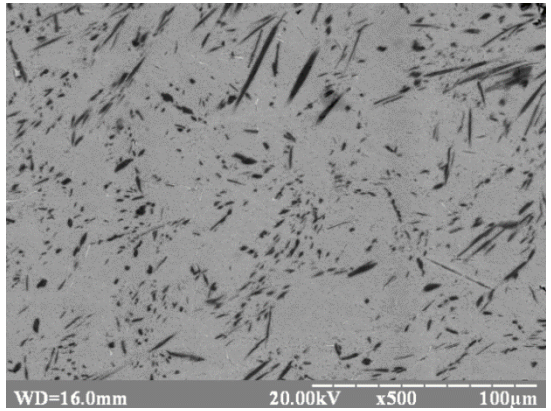

x 100




x 250

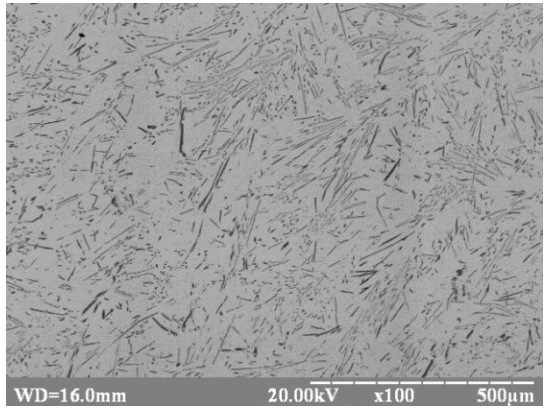



x 500

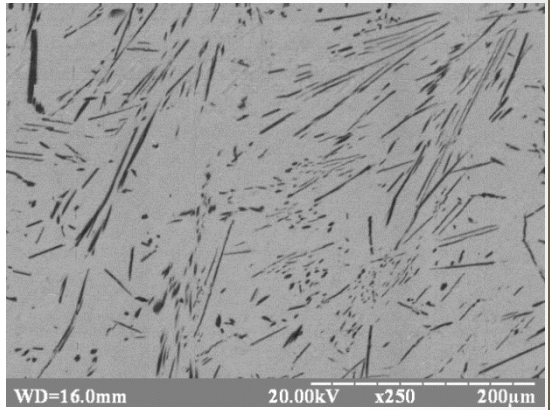



x 1000

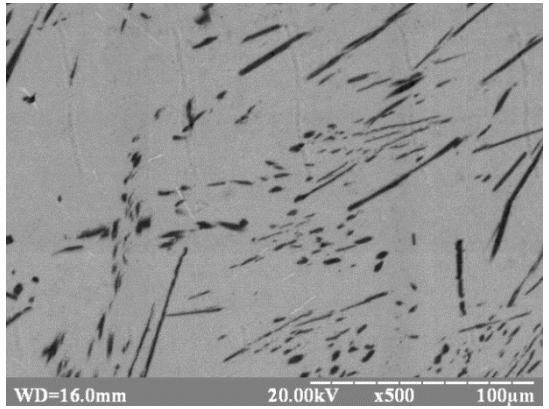
In the direction of crystallization



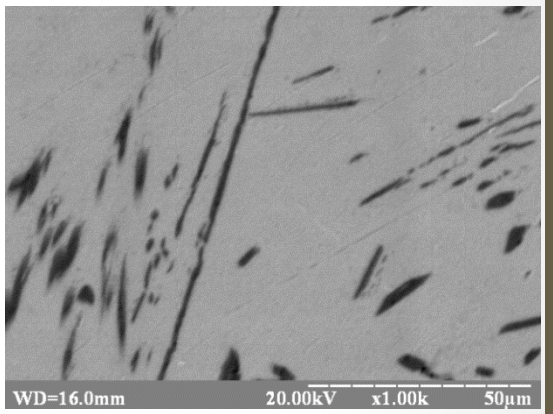

x 100




x 250



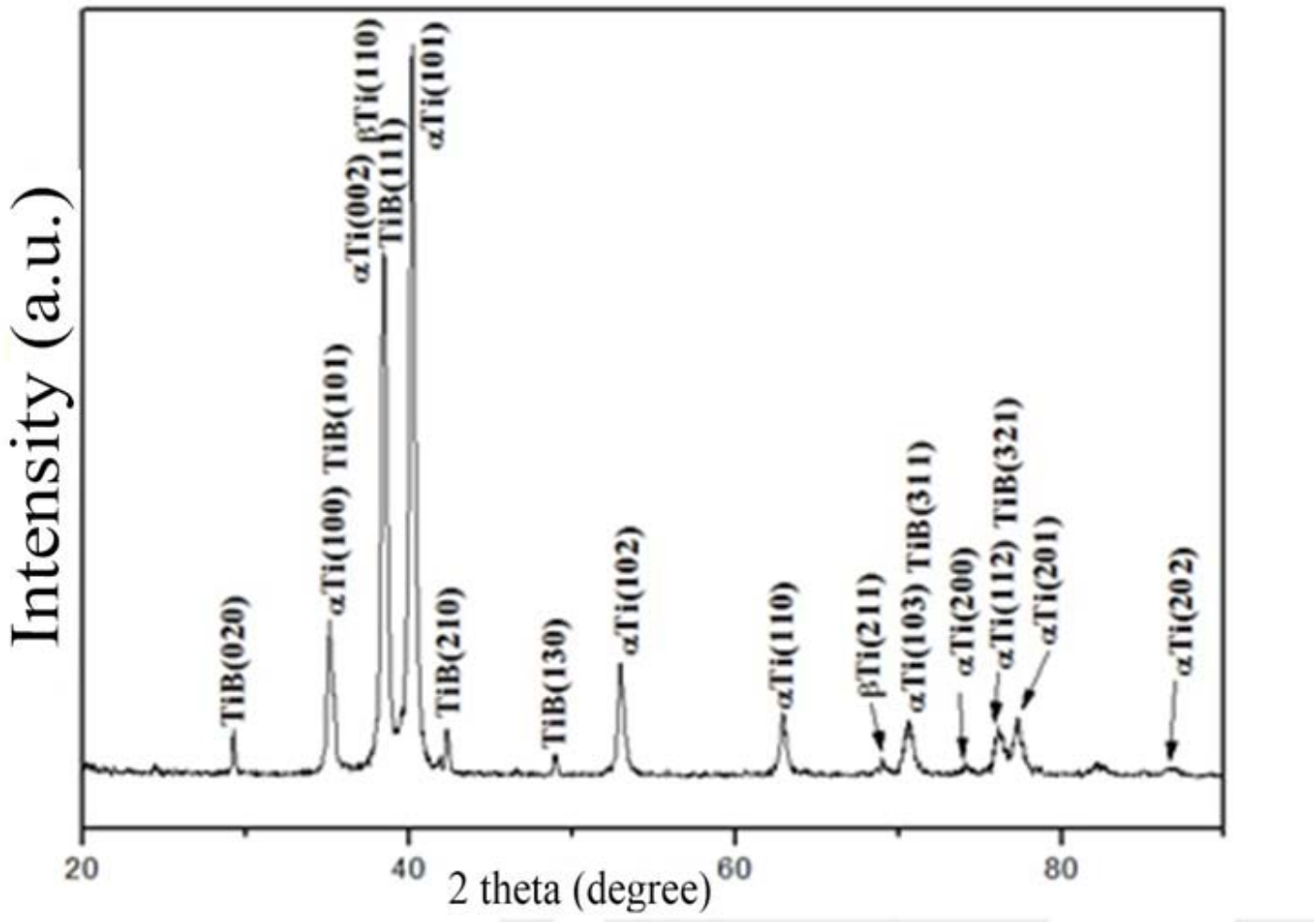

x 500




x 1000

**<u>Sizes of fibres: 3 µm – 72 µm</u>**

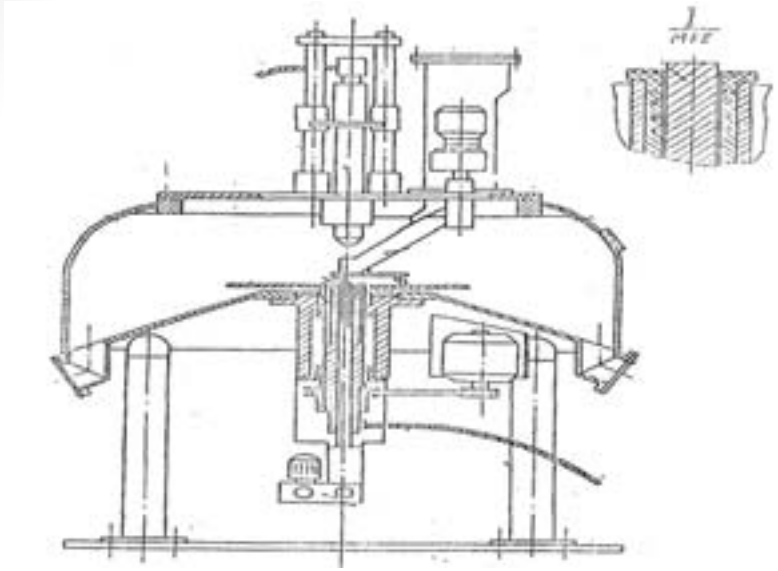
# Phase composition of the composite, obtained by direct crystallization

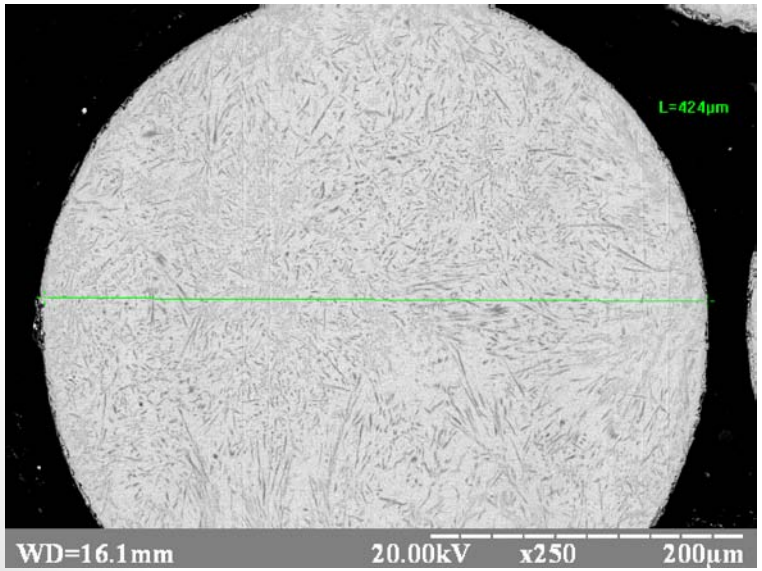


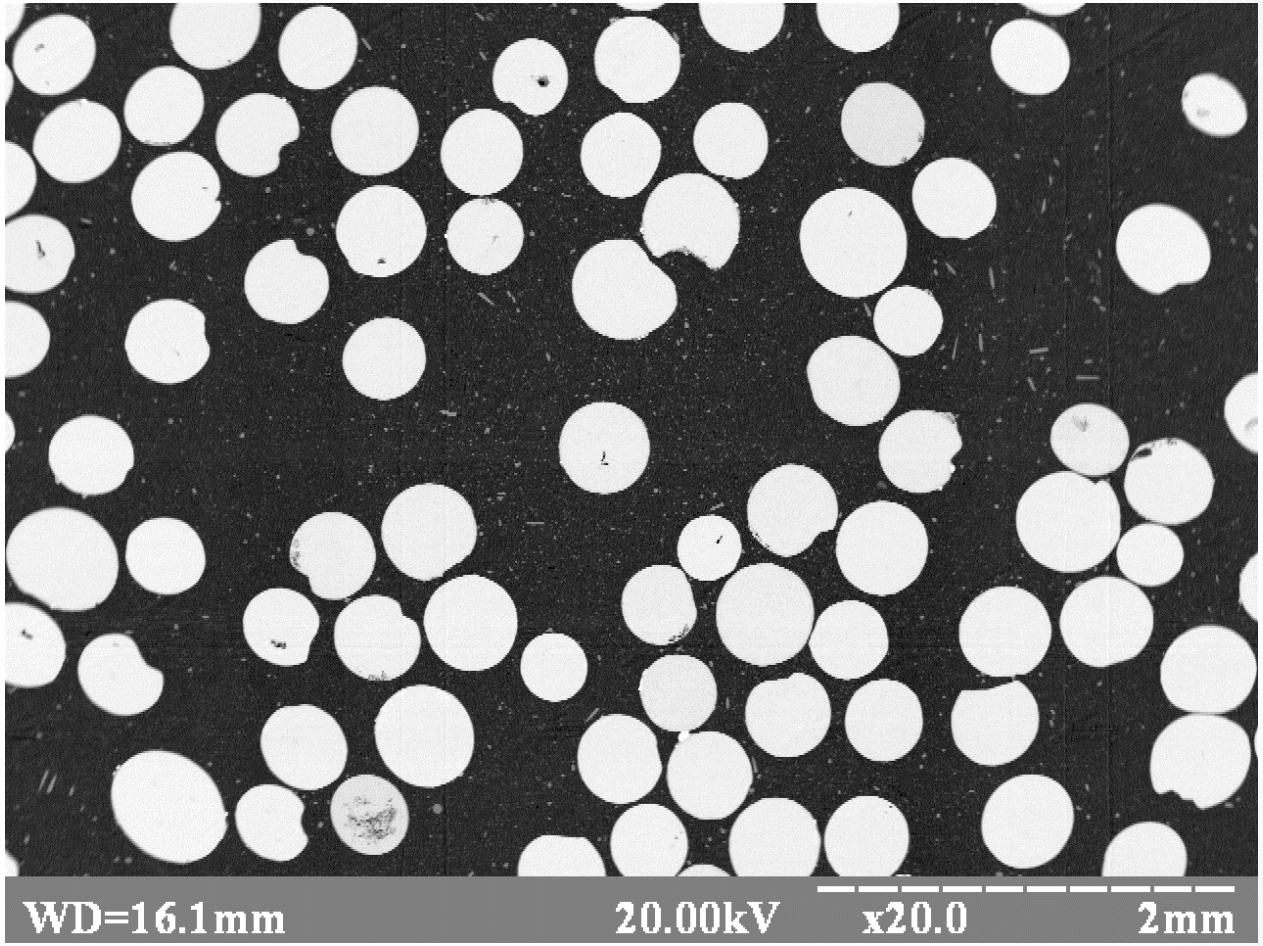

TiB – 6 % wt.

Ti – 94 % wt.

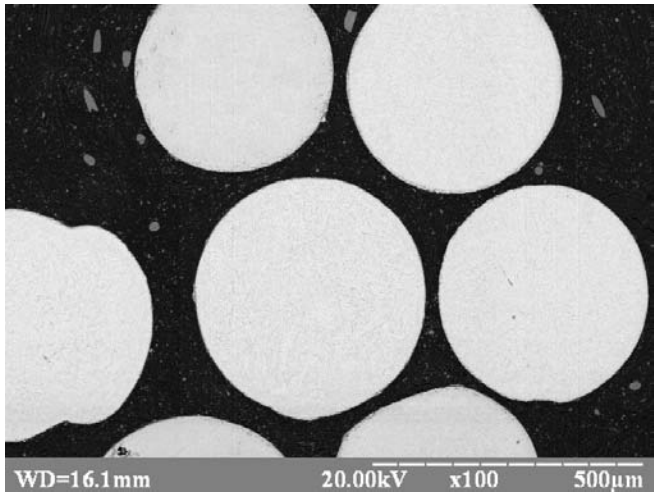
# Centrifugal spraying of eutectic alloy of Ti – TiB system



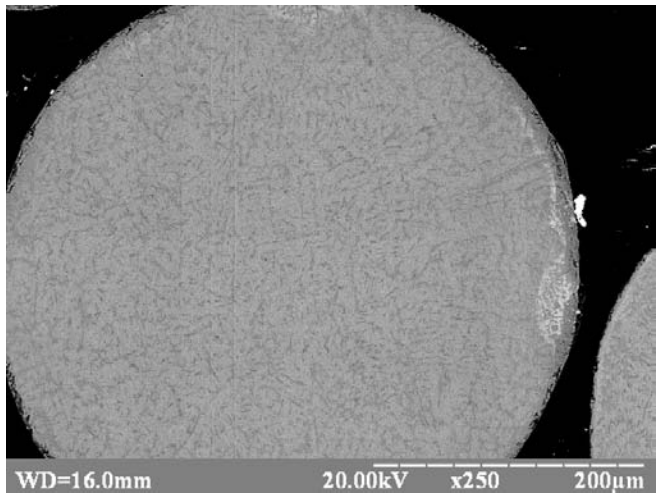


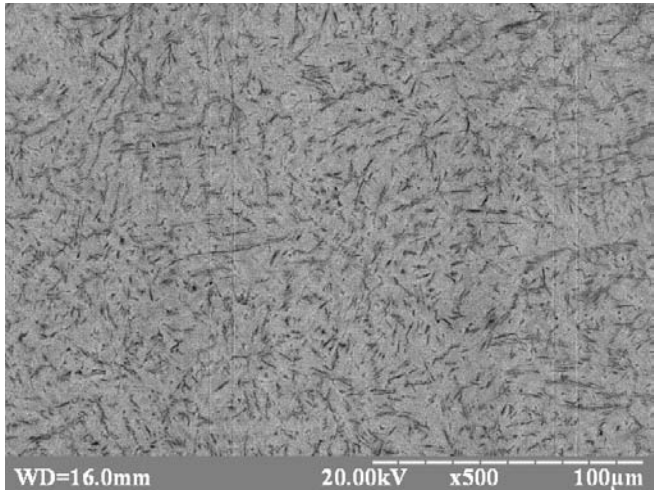
# Microstructure of the alloys, obtained by mass crystallization



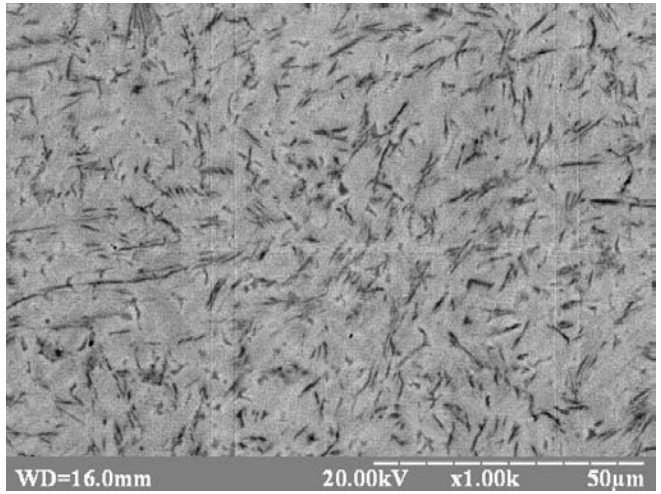

x 100




x 250



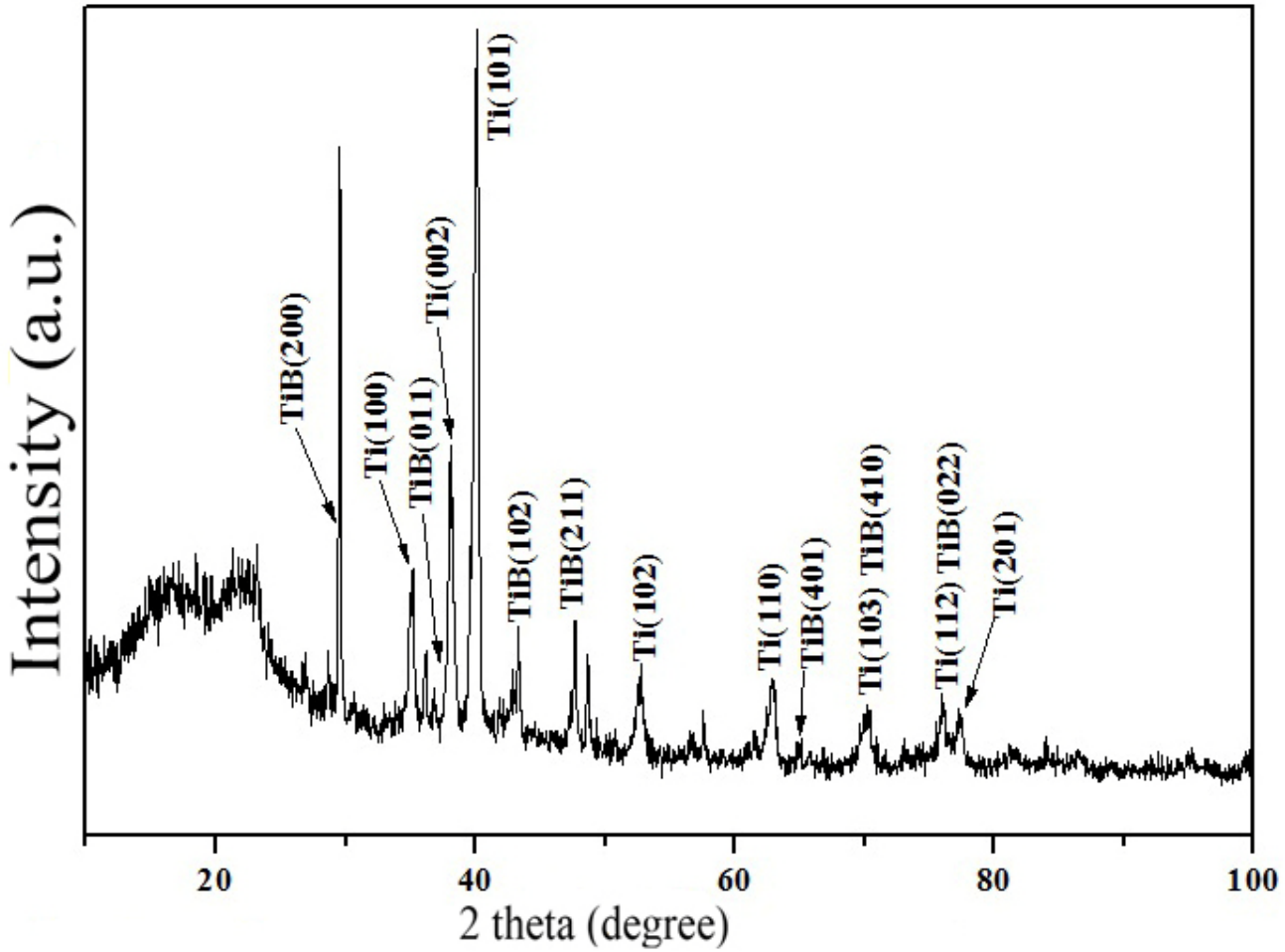

x 500




x 1000

**Sizes of fibres: 1.27 µm – 7.95 µm**

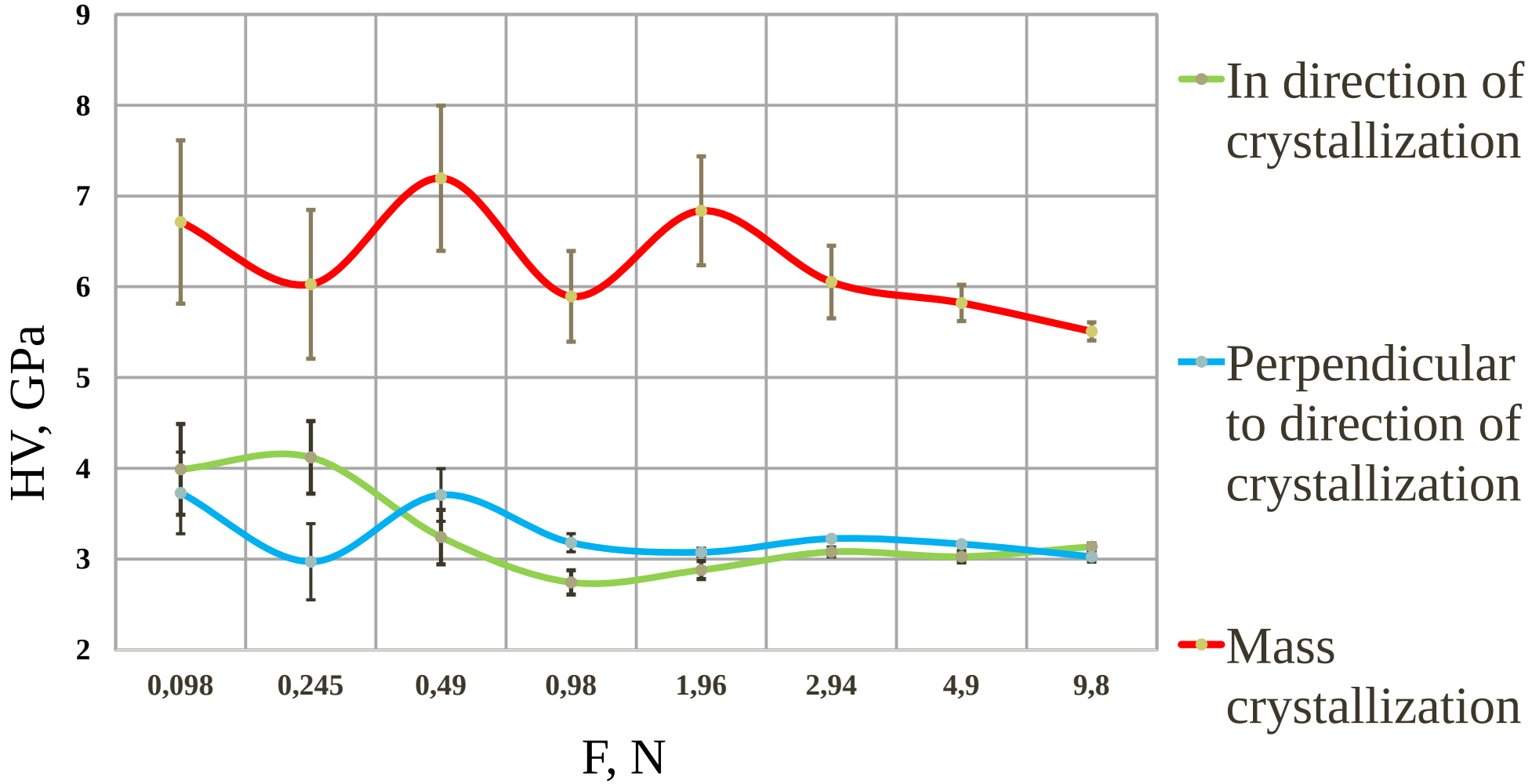
# Phase composition of a composite, obtained by mass crystallization




TiB – 7.1 % мас.

Ti – 92.9 % мас.

# Hardness value in composits



# Conclusions:

1. The effect of the crystallization kinetic parameters on the microstructure, physical and mechanical properties of a eutectic alloy of the Ti-TiB system, which was obtained by direct crystallization of fusion in conditions of float zone melting with refrigeration rate of $10^3$ $^oC$/sec and centrifugal spraying with refrigeration rate of $10^5$$^oC$/sec was studied in this work. It was found that microstructure consists of titanium matrix reinforced with titanium monoboride, regardless of the obtaining method and crystallization rate.
2. It was proved by methods of microscopic metallography and X-ray phase analysis that with the increase of crystallization rate from $10^3$ $^oC$/sec to $10^5$ $^oC$/sec the quantity of reinforcing phase increases from 6 % wt. to 7 % wt.
3. It was established that with the increase of refrigeration rate, geometrical sizes of reinforcement fibers decrease in ten times. Consequently the size the biggest reinforcement fibers obtained at refrigeration rate of $10^3$ $^oC$/sec was 72 µm, and at $10^5$ $^oC$/sec was 7,95µm.
4. It was found that the increase of refrigeration rate leads to the enhancement of mechanical properties. Namely hardness value increases from 3,7 GPa to 5,5 GPa with load of 9,8 N. It can be explained by bigger number of titanium monoboride fibers and an increase of an reinforcement-matrix interface.

# Thank you for attention