ASX RELEASE

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Summary Update on UNSW-TOPFIBRE Research Programme

Chase Mining Corporation Limited ("CML" or "Company") is pleased to release a summary of the most recent report from the University of New South Wales ("UNSW") which covers the activities from 17 August 2019 to 15 October 2019 on advances made.

Topfibre Pty Ltd which is a wholly owned subsidiary of the Company is the UNSW's industry partner in the research project which is now in its third year of the 3-year tenure.

Attached is a summary of the report as supplied by Professor Charles C Sorrell and team of these results.

For, and on behalf of, the Board of Directors of Chase Mining Corporation Limited:

Dr Leon Pretorius

Executive Chairman

Chase Mining Corporation Limited

22 October 2019

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UNSW-Chase Mining RESEARCH PROGRAM

Summary of

Progress Report 13

Alumina Template Fabrication

Thick Mullite Fibre Growth

Mullite Preform Fabrication

Molten Al-Si Alloy Infiltration

17 August – 15 October 2019

Following

Interim Report 30 June – 31 July 2019

Interim Report 16 August 2019

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Executive Summary

Topic 1 – Fabrication of α-alumina templates

The α-Al_2O_3 platelets were thickened successfully by ~50% by coating twice on a polycrystalline α-Al_2O_3 crucible. However, the stacked arrays did not cover the entire surface, leaving the thinner α-Al_2O_3 platelets exposed. A third layer of even thicker α-Al_2O_3 platelets ~150% thicker than the first layer, also formed, probably as a secondary precipitation event.

Excess sodium silicate appears to have etched regions of the growing α-Al_2O_3 platelets, leaving large pores in the stacks.

Topic 2 – Growth of thick mullite fibres

While the potential to thicken the fibres to diameters greater than the limitation of 3 μm for respirable fibres was confirmed, a wide range of diameters still is being produced. The successful thickening of the α-Al_2O_3 platelets appears to be a key aspect of this ability, although the presence of the layer of thinner α-Al_2O_3 platelets from the first coating probably contributed to the range of sizes produced.

The importance of the use of TFA was confirmed since the fibre thicknesses observed in the present work, which was done without TFA, were slightly less than those observed when TFA was present (see Progress Summary 12).

The growth of mullite fibres of ~75 μm length suggests the potential to harvest these mullite fibres by the crude methods of dislodgement by abrasion or crushing, which would yield fibres in the desired length range of 10-35 μm for reinforcement of metal and ceramic matrix composites.

The use of excess sodium silicate was not beneficial as it actually hindered mullite fibre formation through the formation of clusters of α-Al_2O_3 platelets.

The importance of the α-Al_2O_3 templates was confirmed as it was observed by direct comparison that fibres grown using the α-Al_2O_3 templates were significantly thicker than those grown from a bed of topaz.

The processing conditions used were conducive to minimisation of mullite fibre intergrowths, which enables fibre separability.

Topic 3 – Fabrication and infiltration of mullite preforms

The porosity was increased successfully with the use of stearic acid and rubber tyre fillers.

Large-scale wetting and penetration of both the fine porosity between the mullite fibres and the coarse porosity generated by the fillers was not observed. However, isolated regions of wetting and penetration by $Al_{82}Si_{18}$ were observed, demonstrating that, in agreement with published reports, wetting and penetration are possible.

The principal reason for the poor wetting and penetration was that the alloy was too viscous owing to insufficient temperature and time, possibly insufficient porosity, and overly refractory Al-Si alloy composition.

Results and Discussion

Topic 1 – Fabrication of α-alumina templates

The goal of this work was to increase the thickness of the α-Al_2O_3 platelets. When a single coating was applied, the α-Al_2O_3 platelets generated were thin and they incompletely covered the α-Al_2O_3 crucible bottom. A second coating was applied in order to provide a larger growth surface conducive to thick fibre growth over a more comprehensive area over the α-Al_2O_3 crucible bottom. As shown in **Figure 1**, this work was successful, resulting in an increase in α-Al_2O_3 platelet thickness from ~50 nm (dark bottom layer) to ~75 nm (middle light layer). Further, it can be seen that this second coating process also resulted in secondary deposition of a third layer of ~125 nm (thin top light layer).

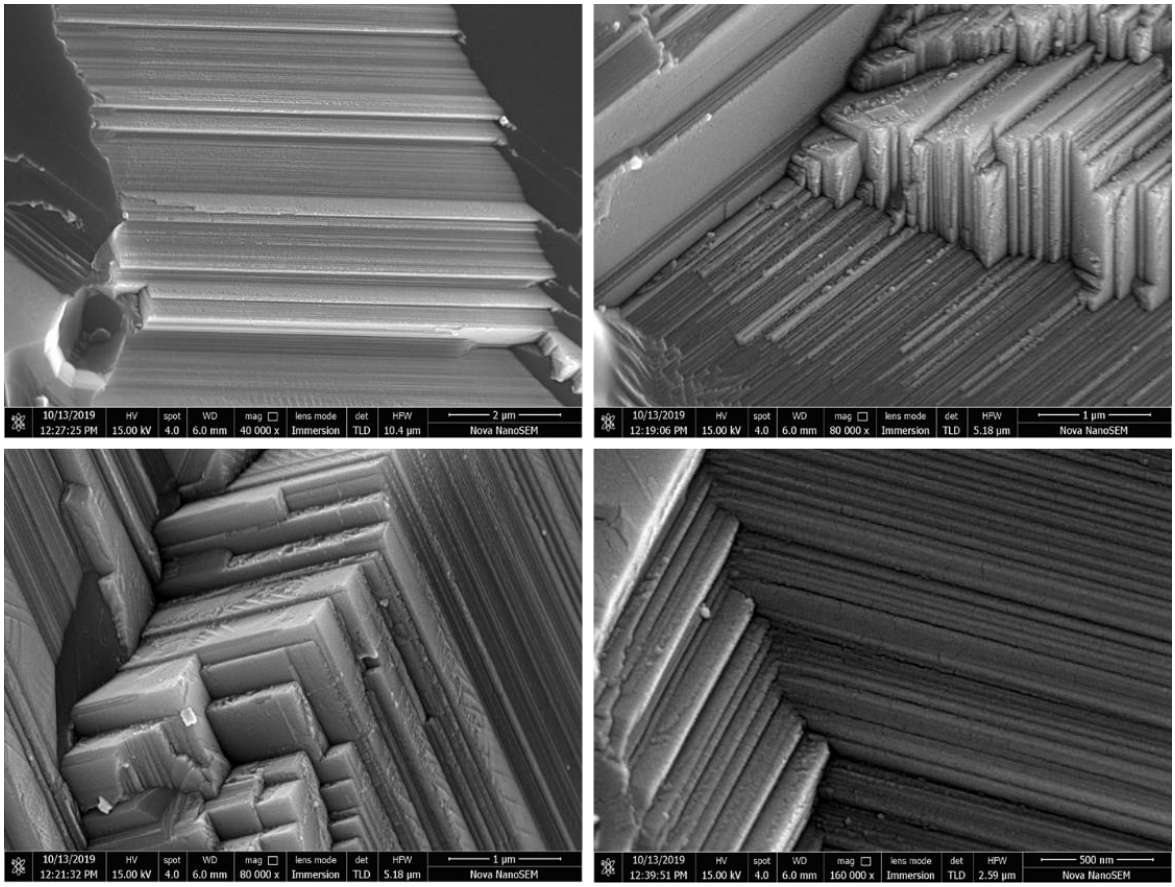

Figure 1. Second α-Al_2O_3 coating | NaSi | 750°C/min | 1500°C | 4 hours | Sealed

Topic 2 – Growth of thick mullite fibres

This work confirms the proof-of-concept that fibres of diameter greater than the respirable limitation of 3 µm can be grown. However, despite the presence of thicker α-Al_2O_3 platelets for templating, a wide range of diameters still is being produced, as shown in **Figure 2**. It is likely that one of the reasons for this is that the surfaces of the α-Al_2O_3 templates (crucible bottoms) were not coated completely with the thicker α-Al_2O_3 platelets, leaving a large proportion of thin α-Al_2O_3 platelets available for mullite growth. However, these processing conditions are suitable to achieve lengths approximately 2-3 times those desirable for fibre reinforcement, which is advantageous for harvesting by simple breakage. It also is clear that these processing conditions also succeed in minimising fibre intergrowths, which is an advantage for harvesting.

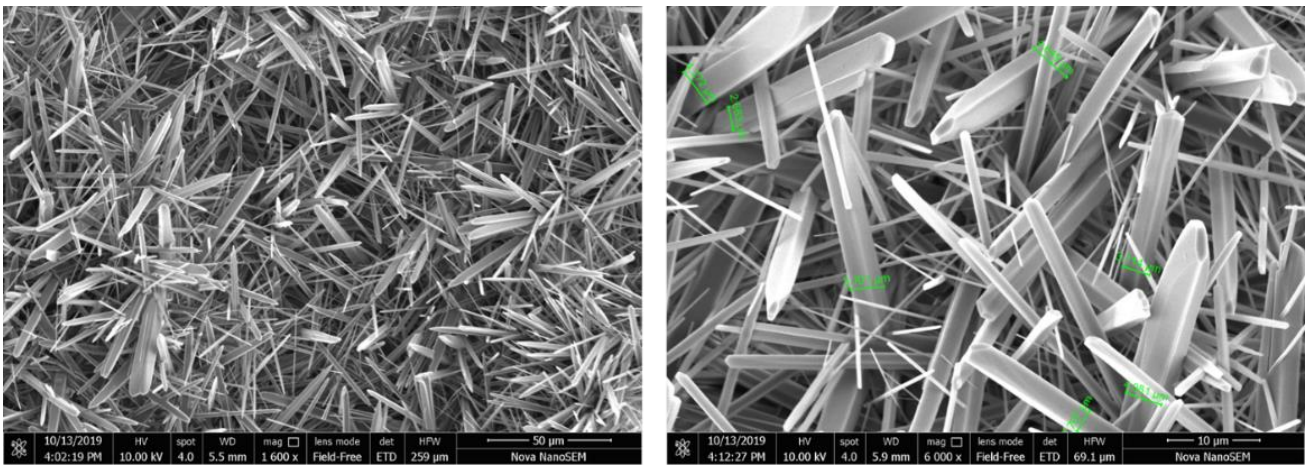

Figure 2. Mullite growth on oriented α-Al_2O_3 template | NaSi | 750°C/min | 1500°C | 12 hours | Sealed

Topic 3 – Fabrication and infiltration of mullite preforms

Extensive molten metal infiltration was not achieved, as shown in **Figure 3**. The reason for this is not intrinsic to the combination of materials of preform (mullite) and alloy ($Al_{82}Si_{18}$), which is demonstrated by a range of publications reporting successful wetting of mullite by Al-based alloys.

The probable reasons for the failure to wet and penetrate are as follows:

- *Insufficient temperature* — A minimal temperature of ~1100°C appears to be necessary (the temperature used was ~800°C).
- *Insufficient time* — A minimal time of ~10 min appears to be necessary, although typical testing times are in the range 30-120 min (the time used was <1 min).
- *Insufficient porosity* — Apparent porosities in the range ~20-25% appear to be optimal (the apparent porosity appears to be lower than this).
- *Need for reactive metal* — A reactive metal, such as Mg, Ti, or Cu, enhances the wetting (the Si was intended as a reactive metal but its effect was insufficient).
- *Excessive Si alloy content* — The liquefaction temperature of the Al-Si alloy was too high (decreasing the Si level will reduce this temperature).
- *Lotus effect* — The asperities created by the mullite fibre ends may hinder penetration by the viscous alloy (the low temperature used did not decrease the viscosity sufficiently to allow flow).

Figure 3. Initial attempted infiltration of mullite preform

Future Work

Mullite fibre thickening

1) Continue efforts to thicken fibres through further work on:
    a) Thickening α-Al_2O_3 platelets
    b) Addition of Al salt to combine with NaSi to enhance mullite formation
    c) Addition of different concentrations of TFA
    d) Addition of a solid source of F
    e) Deposition of carbon with the use of organic fillers
2) Examine separability of fibres through work on:
    a) Dislodgement from the surface by abrasion
    b) Crushing

Increased wetting and penetration of mullite preforms by molten alloys

3) Examine increased wetting and penetration of mullite compacts through further work on:
    a) Increased temperature
    b) Increased time
    c) Increased porosity
    d) Addition of a second reactive metal
    e) Decreased Si level of the Al-Si alloy