

24 May 2024

## Tivan & CSIRO successfully complete TIVAN+ Testwork Program

- Tivan and CSIRO, Australia's national science agency, have successfully completed a significant development testwork program for the TIVAN+ critical minerals processing technology.
- Testwork outcomes have exceeded expectations, delivering excellent results that confirm the technical viability of processing Speewah concentrate with the TIVAN+ technology.
- TIVAN+ is designed to recover vanadium, titanium and iron from vanadium titanomagnetite, providing an opportunity to reshape global supply chains and downstream industrial pathways in the critical minerals of vanadium and titanium.
- High-grade magnetite returned using TIVAN+ has highlighted the potential of the product as a high-quality feedstock for a direct reduced iron (DRI) process for the production of "green steel".
- Tivan has an exclusive 20 year worldwide licence (except India) from CSIRO for the TIVAN+ technology, initially focused on Tivan's 100% owned Speewah Vanadium Project.
- Tivan is advancing discussions with two asset owners of vanadium titanomagnetite resources that have expressed interest in the utilisation of TIVAN+ technology.
- Tivan will review its strategy for the Speewah Vanadium Project, inclusive of the TIVAN+ pathway, following completion of the Pre-Feasibility Study for the Speewah Fluorite Project in July.

The Board of Tivan Limited (ASX: TVN) ("Tivan" or the "Company") is pleased to advise that a significant development testwork program has been completed for the TIVAN+ critical minerals processing technology, confirming the technical viability of processing vanadium titanomagnetite ("VTM") concentrate from the Speewah Vanadium Project in Western Australia with the TIVAN+ technology.

The testwork program focused on assessing the TIVAN+ technology flowsheet developed between CSIRO and Tivan utilising Speewah concentrate, with the objective of validating the technology and supporting future process engineering and pilot plant design. Testwork outcomes have exceeded expectations, delivering excellent results in the flowsheet areas of leaching and product recovery.

The testwork program was delivered under a Research Services Agreement between Tivan and CSIRO. CSIRO is Australia's national science agency and is one of the largest and most multidisciplinary mission-driven research organisations in the world, operating at 49 sites across Australia and sites overseas.

Tivan announced in November 2023 that it has secured a long-term commercial and strategic partnership with CSIRO to facilitate collaborative development and commercialisation of the TIVAN+ critical minerals processing technology for the recovery of vanadium. The partnership was established through the execution of two agreements:

- Technology Licence Agreement ("TLA"): providing Tivan with an exclusive, non-transferable 20 year licence (excluding India) to use CSIRO's specified VTM intellectual property, patents, know-how and any further improvements thereto for the recovery of vanadium in the form of the TIVAN+ technology.

- Research Services Agreement (“RSA”): establishing the agreed pathway for technology development and optimisation including the testwork program to validate the TIVAN+ technology flowsheet utilising Speewah concentrate.

*For further details of the strategic partnership with CSIRO, refer to the ASX announcement of 14 November 2023.*

### **Development Program - Testwork Results**

The TIVAN+ technology has been developed to optimise extraction of value from the vanadium, iron and titanium contained in VTM feedstocks. The technology is based on leaching and selective product recovery (precipitation) processes to recover vanadium pentoxide, magnetite and a titanium pigment feedstock.

Development of the TIVAN+ technology under the RSA has progressed as planned and testing addressing the aspects of leaching and product recovery has finished on schedule. The testwork program undertaken has delivered excellent outcomes, generating positive results that demonstrate the technical viability of processing Speewah concentrate with the TIVAN+ technology.

The purpose of the testwork program was to:

- Investigate risks and opportunities identified for the TIVAN+ technology, developed through integration of aspects of Tivan’s own VTM intellectual property with CSIRO’s VTM processing technology.
- Review the TIVAN+ flowsheet to identify technology gaps in support of testwork definition.
- Validate the TIVAN+ technology flowsheet utilising VTM concentrate from Tivan’s Speewah and Mount Peake Projects.
- Support future process engineering activities.
- Address key technical areas required to support a future TIVAN+ Pilot Plant.

To facilitate the program, CSIRO assembled a team of research scientists and subject matter experts to oversee progression of relevant areas of the TIVAN+ testwork and flowsheet development. The testwork program was conducted at CSIRO’s Mineral Resources facility at Waterford in Perth.

Testwork was performed on high-grade (2.44% V<sub>2</sub>O<sub>5</sub>) Speewah concentrate prepared before Tivan’s acquisition of the Speewah Project. The concentrate was produced in 2011 when approximately six tonnes of RC drilling samples were processed with magnetic separation.

### **Leaching Results**

Leaching testwork on the Speewah concentrate was undertaken to assess vanadium extraction and titanium residue properties. Testwork included a larger bench scale trial with 2.2 kg of Speewah concentrate. The vanadium extraction results for all 25 trials completed for Speewah concentrate are summarised in *Table 1* in *Appendix 1*. The trials delivered excellent results, demonstrating the repeatability of high vanadium extraction within the range of experimental testing parameters. A vanadium extraction of 98.5% was validated with a larger bench scale trial (Tiva45), which is an



excellent result significantly higher than standard industry vanadium salt roast yields from VTM ores. The leaching outcomes also support the CSIRO/Tivan position that the technology will be applicable to alternative VTM deposits.

The leach produces a vanadium bearing solution and a titanium enriched leach residue. The residue from the leach was ~57 to 60% Ti (as  $\text{TiO}_2$ ) in optimised leaching trials. Three selected titanium rich residues from the vanadium leaching trials were submitted for a sulphate digest to test their amenability to the sulphate pigment process. The titanium extraction results are summarised in *Table 2* in *Appendix 1*. Titanium extractions in the range of 87.7% to 94.2% were returned, an outcome which demonstrates that the titanium residue from the TIVAN+ technology has amenability to the sulphate pigment process. As part of the commercial strategy for TIVAN+, Tivan is assessing product specifications for titanium dioxide and exploring opportunities to directly sell or further process the residue for titanium dioxide pigment manufacture.

### **Product Recovery Results**

Earlier testwork on the recovery of a vanadium pentoxide ( $\text{V}_2\text{O}_5$ ) product from the leach liquor was performed on synthetic solutions to establish preferred processing routes and vanadium pentoxide specifications. The final executed tests utilised leach liquor prepared from Speewah concentrate. The targeted high purity (>99.5%) vanadium pentoxide specification was met when utilising Speewah leach liquor, validating the results from previous synthetic solution testing (see ASX announcement 14 November 2023 for synthetic results). Results are summarised in *Table 3* in *Appendix 1*.

The high purity  $\text{V}_2\text{O}_5$  sample was prepared without specialised industry purification steps such as solvent extraction, leaving significant scope for further reduction of the impurities in the TIVAN+  $\text{V}_2\text{O}_5$ . The outcome is important as it supports the Company's vision for use of the vanadium pentoxide product in the preparation of vanadium electrolyte products.

Iron recovery work was performed solely on representative synthetic solutions. The results from the iron recovery tests were very positive, demonstrating the production of target high-grade (>64.5% Fe) iron products with high recovery of iron from solution. Single stage and two stage recovery flowsheets were trialed with both configurations demonstrating near-quantitative (100%) iron recovery from solution. Notably an iron grade of 69.4%, which corresponds to near pure magnetite, was obtained at a lower recovery of approximately 92%. The results highlight the potential for the magnetite to be a feedstock for a direct reduced iron ("DRI") process. DRI feedstocks are typically higher quality than blast furnace iron ore feedstocks, requiring an iron composition of greater than 67%.

The results show there is flexibility for the project to tailor the high-grade magnetite product to the specifications required for downstream vendors. Future work with commercial limestones relevant to the region is required to confirm the high-grade iron oxide product outcomes.



**Image 1: Samples - titanium dioxide (leach trials), magnetite (iron recovery trials), “AMV” (ammonium metavanadate is a pre-cursor to V<sub>2</sub>O<sub>5</sub> preparation) and vanadium pentoxide (vanadium recovery trials) (source: CSIRO)**

## Commercial Update

Under the terms of the TLA with CSIRO for TIVAN+, Tivan is to actively seek to sublicense the TIVAN+ technology to third parties (see ASX announcement of 14 November 2023).

Tivan has received approaches from two independent third parties interested in assessing the suitability of the TIVAN+ technology for their vanadium titanomagnetite deposits. Tivan is working through preliminary assessment phases with these third parties to determine desktop technical applicability, and if warranted define proposed preliminary testwork requirements on third party deposit samples to be undertaken in conjunction with CSIRO.

Tivan notes that while there is third party interest in the TIVAN+ technology, there is no guarantee or certainty that a sublicensing agreement will eventuate.

## Next Steps

Tivan is currently focused on progressing the Speewah Fluorite Project and scheduled to deliver the Pre-Feasibility Study (“PFS”) in July.

Following the completion of the PFS, Tivan will undertake a comprehensive review of its strategy and planning for the Speewah Vanadium Project. The principal aim of the review will be to evaluate a preferred development pathway as between traditional salt roast processing and the TIVAN+ technology pathway. The review will encompass the extensive body of work that Tivan completed in advancing the salt roast pathway between September 2023 and February 2024, in conjunction with Hatch Engineering (see ASX announcement of 22 September 2023).



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In respect of TIVAN+, the review will encompass the extensive body of work completed with CSIRO over the past year and the testwork results reported today. It will evaluate the pathway to the planning and construction of a large-scale TIVAN+ Pilot Plant, including potential funding through commercial arrangements and various Australian government programs. The Board notes that the recent 2024-25 Federal Budget includes significant funding for innovative projects that build sovereign capabilities and that accelerate the energy transition.

Tivan will report the findings of this comprehensive review in Q3. Meanwhile, Tivan will continue to rapidly advance the Company's strategic priorities in 2024, being the Speewah Fluorite Project and the Sandover Project.

**Tivan Executive Chairman Mr Grant Wilson commented:**

*"A year on from our decision to break from the TIVAN® flowsheet, we are delighted to report the first testwork results of our strategic partnership with CSIRO. The results confirm the technical viability of TIVAN+ and the amenability of the technology pathway to the Speewah resource. These are critical foundational steps and the result of extensive collaboration between Tivan and CSIRO.*

*The success of the testwork program means that Tivan can now evaluate the traditional salt roast pathway against the TIVAN+ technology pathway. This important exercise will occur in Q3. If we decide in favour of TIVAN+, we will move directly toward the planning and construction of a large-scale TIVAN+ Pilot Plant. From a scheduling perspective, there is scope to construct a TIVAN+ Pilot Plant whilst we are delivering the Speewah Fluorite Project.*

*The Board of Tivan extends its congratulations to the team at CSIRO. The testwork results are fantastic and offer scope to build important sovereign capabilities that advance the energy transition. A TIVAN+ Pilot Plant would be a breakthrough achievement in critical minerals processing and would be 'Made in Australia'.*

This announcement has been approved by the Board of the Company.

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## Forward looking statement

This announcement contains certain “forward-looking statements” and comments about future matters. Forward-looking statements can generally be identified by the use of forward-looking words such as, “expect”, “anticipate”, “likely”, “intend”, “should”, “estimate”, “target”, “outlook”, and other similar expressions and include, but are not limited to, the timing, outcome and effects of the future studies, project development and other work. Indications of, and guidance or outlook on, future earnings, financial position, performance of the Company or global markets for relevant commodities are also forward-looking statements. You are cautioned not to place undue reliance on forward-looking statements. Any such statements, opinions and estimates in this announcement speak only as of the date hereof, are preliminary views and are based on assumptions and contingencies subject to change without notice. Forward-looking statements are provided as a general guide only. There can be no assurance that actual outcomes will not differ materially from these forward-looking statements. Any such forward looking statement also inherently involves known and unknown risks, uncertainties and other factors and may involve significant elements of subjective judgement and assumptions that may cause actual results, performance and achievements to differ. Except as required by law the Company undertakes no obligation to finalise, check, supplement, revise or update forward-looking statements in the future, regardless of whether new information, future events or results or other factors affect the information contained in this announcement.

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### Appendix 1 - RSA testwork program results

| Trial                | Vanadium Extraction |
|----------------------|---------------------|
| Tiva19               | 97.1%               |
| Tiva22               | 97.5%               |
| Tiva23               | 97.1%               |
| Tiva24               | 97.2%               |
| Tiva25               | 97.7%               |
| <b>Tiva26</b>        | <b>98.5%</b>        |
| Tiva27               | 97.4%               |
| Tiva28               | 98.0%               |
| Tiva29               | 96.9%               |
| Tiva30               | 92.7%               |
| Tiva31               | 96.6%               |
| Tiva32               | 91.5%               |
| Tiva33               | 95.0%               |
| Tiva34               | 97.9%               |
| Tiva35               | 95.5%               |
| Tiva36               | 96.1%               |
| Tiva37               | 96.5%               |
| Tiva38               | 96.2%               |
| Tiva39               | 98.2%               |
| Tiva40               | 97.0%               |
| Tiva41               | 97.3%               |
| Tiva42               | 96.9%               |
| <b>Tiva45 (bulk)</b> | <b>98.9%</b>        |
| Tiva47               | 98.6%               |
| <b>Tiva48</b>        | <b>98.8%</b>        |

**Table 1: Vanadium extraction data for vanadium leach trials (source: CSIRO); variety of different conditions were trialled, with key outcomes demonstrated in trials Tiva26, Tiva45 and Tiva48**

| Sample | Test ID | Titanium Extraction |
|--------|---------|---------------------|
| Tiva45 | 18079   | 91.5%               |
| Tiva45 | 18080   | 94.2%               |
| Tiva47 | 18081   | 87.7%               |
| Tiva48 | 18082   | 87.9%               |

**Table 2: Titanium extraction data from sulphate digest trials (source: CSIRO, from work performed at ALS); all trials conducted under the same operating conditions**



| Composition  | Units | Assay |
|--|-------|-------|
| V  | %     | 56.03 |
| Al <sub>2</sub> O <sub>3</sub>                     | %     | 0.019 |
| Fe <sub>2</sub> O <sub>3</sub>                     | %     | 0.014 |
| TiO <sub>2</sub>                                   | ppm   | 5.01  |
| Cr <sub>2</sub> O <sub>3</sub>                     | ppm   | 56.3  |
| MgO  | %     | 0.017 |
| CaO  | %     | 0.014 |
| SiO <sub>2</sub>                                   | %     | 0.021 |
| P  | %     | 0.001 |
| S  | %     | 0.001 |
| K  | %     | 0.001 |
| Na   | %     | 0.010 |
| Cl   | %     | 0.001 |
| As <sub>2</sub> O <sub>3</sub>                     | ppm   | 0.26  |
| CdO  | ppm   | 0.11  |
| Co <sub>2</sub> O <sub>3</sub>                     | ppm   | 0.14  |
| CuO  | ppm   | 5.01  |
| MnO  | ppm   | 1.29  |
| MoO <sub>3</sub>                                   | ppm   | 677   |
| NiO  | ppm   | 3.82  |
| PbO  | ppm   | 1.08  |
| Sb <sub>2</sub> O <sub>3</sub>                     | ppm   | 29.9  |
| ZnO  | ppm   | 6.22  |
| Sum of impurities*                                 | %     | 0.18  |
| Calculated purity (V <sub>2</sub> O <sub>5</sub> ) | %     | 99.82 |

**Table 3: Chemical composition data for Speewah vanadium pentoxide (V<sub>2</sub>O<sub>5</sub>) sample (source: CSIRO, from analyses performed at Bureau Veritas)**