

Being Smart about Green Electronics

Advanced manufacturing is the rapid transfer of science and technology into manufacturing processes & products. The Advanced manufacturing value chain is designed to bring products to market - faster. An optimal value chain is the strategic connection of products, processes, business models, speed, and globalization.

ReMAP M1-3 have identified a potential market disruption through the greening of aerospace electronic materials in design and composition. They aim to be commercially available to meet the European Union's 2019 lead-free deadline (Restriction of Hazardous Substances, ROHs compliant). This is how the value chain evolved to work for them.

Essentially, products and processes are the result of an idea tested and refined through research. Private enterprise developed a business model that consisted of a product-to-market strategy. Next, the ReMAP network connected industry partners who supported researchers with tools for success to advance commercialization.

Private Partners

In 2014, the original ReMAP M1-3 partners were University of Toronto, Celestica, Curtiss-Wright and Honeywell.

Rockwell-Collins and BAE Systems joined the original partners in 2015. Rockwell-Collins, a leader in aviation electronics, contributed expertise in design and production. BAE Systems, (a global company that develops, engineers, manufactures and support products and systems for Aerospace and Defense) joined as advisors.

Lockheed Martin informally advised as a future commercial user of the materials (even though there was potential competition) and in 2015, Indium joined the project as an industry advisor.

HQP

□ The ReMAP M1-3 collaboration among Celestica, University of Toronto, Honeywell, Rockwell Collins, Curtiss-Wright and BAE Systems provides educational and training opportunities for 1 PhD candidate, 3 PhDs and Post Docs with industry partners in lab environments that simulate real conditions for aerospace electronics manufacturing in Canada. These training and education opportunities strengthen the link between research and industry. Industry HQPs employ 5 Engineers and multiple technical support staff.

TRL Progression

ReMAP M1-3 entered at TRL 4 in 2014 and progressed to TRL 6-7 in 2017. This was a result of hard work and commitment to a successful collaboration between partners.

Two patents applications were made in 2014-15 FY for, a. Solder Joint Thermal Preconditioning for Microstructure and Properties Improvement, and b. Restoration Process for Improving Reliability and Field Life of SnAgCuBi electronic assemblies.

In 2015-16, ReMAP M1-3 released two products to market, 1) Pb-Free High Reliability Alloy with Bi & 2) Pb-Free Assembly. A USA Patent Application was filed in 2017, for *Thermal Treatment for Preconditioning and/or Restoration of a Solder Joint*.

Market

Early adopters of the new alloys will gain a competitive advantage by offering reliable and lower cost electronics products from market-leading research as trusted manufacturers. Currently there is no industry test protocol for Combined Environmental Testing and no available Pb-free solder for high reliability applications. Testing with multiple industry consortiums (HdPug, iNEMI, CALCE and NASA), are investigating the new alloys and processes.

Forward thinking estimations from project partners include approximately \$100M annually from the M1-M3 project outcomes. Additional network partners anticipate \$80M in revenues, as well as additional earnings from licensing and tech transfer to the private sector.

ReCAP

The projects, jointly funded by the ReMAP network and industry partners, have produced patent-pending lead-free alloys that are highly reliable and meet performance demands. Ontario is poised to advance Canada by offering lower cost 'green' electronic products to the aerospace market with opportunities to diversify into other sectors.