New monomer of (-)-Dihydrolevoglucosenone (Cyrene™) and new polymer coatings

PHYSICAL SCIENCES: Materials

The Challenge	Additives such as to isobornyl methacrylate (IBMA) are primarily used in industrial paints and coatings, for metal, glass and plastics. It is desirable for certain demanding applications using polymeric coatings that further improvements in thermal stability and hardness are achieved. Other challenges for paints and coatings are to minimise the quantity of expensive specialty monomers used in a polymerisable formulation, while maintaining acceptable properties. In addition to reducing the amount of additive needed, it is now considered important to replace additives with bio-derived material from sustainable resources.
The Solution	(-)-Dihydrolevoglucosenone (Cyrene™) is synthesised from Australian pine wood as a green solvent. Monash researchers have developed polymers of methacrylic (-)-dihydrolevoglucosenone (Cyrene™). Coatings containing this polymer have excellent thermal stability and rigidity/hardness.
Key benefits	• New polymer for coatings additive made from 'green' bio-derived monomer • Improved Thermal Stability compared to IBMA • Higher T_g (rigidity, hardness) compared to IBMA • Fast polymerisation kinetics compared to IBMA • Tests suggests polymer has low toxicity
Development Stage	Proof of Concept
Brief Description & Differentiation	• New methacrylic monomer from (-)-dihydrolevoglucosenone (Cyrene™), a high-temperature boiling green solvent. • Easy and scalable two-step synthesis process with high overall yield. • Kinetics study demonstrates fast polymerization using polar solvents / water (emulsion polymerization). • Homopolymer glass transition temperature (T_g): 162°C for bulk polymerization and 193°C for emulsion polymerization - believed to be one of the highest reported for methacrylic polymers (Fig. 1). • High glass temperature gives rise to high rigidity and hardness, making it suitable for applications requiring high mechanical strength. • Homopolymer stable up to 290°C for bulk phase polymerisation or 310°C for emulsion polymerisation (Fig. 2) - considered acceptable for automotive OEM and refinish applications requiring high temperature baking of polymeric resins. • Addition of monomer (10% by w/w) into a coating formulation increased the molecular weight (MW) by 7,000, the polydispersity (Đ) by 2.0, T_g by 25°C and thermal stability by 100°C, making it a very suitable candidate for coating formulations. • Cytotoxicity test: monomer is non-toxic against skin cells and hence believed to be safe to handle.
Research Team	Led by Assoc Prof Kei Saito (School of Chemistry) and Prof George Simon (Department of Materials Science)
Intellectual Property	PCT application filed in 2019 (PCT/AU2019/051371)

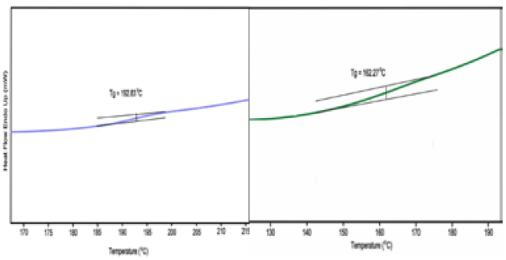

Figure 1. Glass transition temperature of methacrylic derivative of Cyrene™ homopolymer by emulsion polymerisation (left) and bulk polymerisation (right).

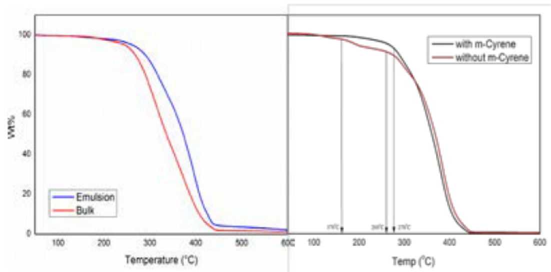

Figure 2. Thermal stability of methacrylic derivative of Cyrene™ homopolymers (left) and coatings with and without methacrylic derivatives of Cyrenre™ (right).