TEXAS WOMAN'S UNIVERSITY™

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Recycling Electronic Waste: A 21 st Century Challenge

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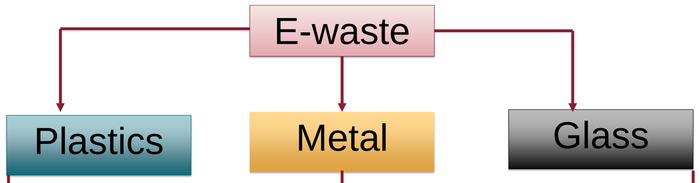
Introduction and Background

Electronic waste (E-Waste) can be defined as waste material from electric appliances. Currently, a large quantity of E-Waste ends up in landfills, where it can have adverse effects on the environment. Furthermore, E-Waste management is rapidly becoming a global issue due to the difficulty of recycling the key components for reuse.

General Separation Treatments of E-waste



Pyrolysis:
The application of heat without the use of oxygen. This process is used to melt the solders in circuit boards releasing many precious metals for separation.

Hydro- metallurgy:
Uses aqueous chemistry, to extract metals from various components of E-Waste. The process is known as leaching which uses the liquid as a carrier for metals.

CRT Re- manufacturing:
Cathode Ray Tubes (CRT) funnel glass is crushed then mixed with fresh material to be remade into a new CRT.

Treatment of Glass:
Once the cullets are manually/automatically separated, they must be treated. Hydrometallurgy and high heat processes are used to remove unsafe chemicals in the glass such as lead before being reused.

Separation:
E-waste appliances are shredded and then the reusable plastics go through manual/automated systems where they are separated.

Polymer Separation:
This process uses extractive metallurgy, ion exchange and many more techniques. ***E-waste plastics are mainly complex polymers difficult to separate efficiently.***

Current Difficulties of Managing Plastic E-Waste

There are many difficulties when dealing with plastic from E-Waste the largest being the complex polymer composition which is unlike many household plastics that are regularly recycled. Due to the composition of these plastics and the presence of brominated flame retardants resulting in traditional processes of recycling plastics proving insufficient. This has resulted in a majority of the plastic ending up in land fills where the chemicals the plastic was treated with will leach into the environment. Brominated chemicals have been linked with endocrine and neurological damage in humans, which has lead to infertility in adults and impaired mental development in children. To make matters worse, brominated flame retardants bioaccumulate which means that the chemical does not dissipate one it is within the environment it instead lingers and only builds upon itself.

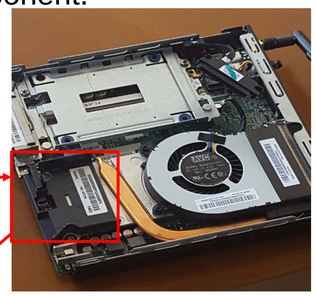
First Review of Green Chemistry in E-waste Treatments

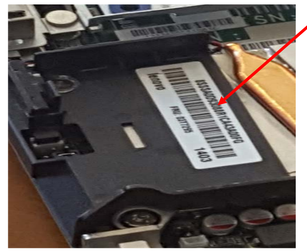
12 Green Chemistry Principles	Smelting/ Incineration	Pyrolysis	Steam Gasification
Prevention	✓	✓	✓
Atom Economy	✓	✓	✓
Less Hazardous Chemical Syntheses	✓	✓	✓
Designing Safer Chemicals	✓	✓	✓
Safer Solvents and Auxiliaries			
Design for Energy Efficiency			
Use of Renewable Feedstocks	✓	✓	✓
Reduce Derivatives	✓	✓	✓
Catalysis			
Design for Degradation	✓	✓	✓
Real-time analysis for Pollution Prevention	✓	✓	✓
Inherently Safer Chemistry for Accident Prevention			

✓ The process meets the minimum requirement to implement a principle of green chemistry

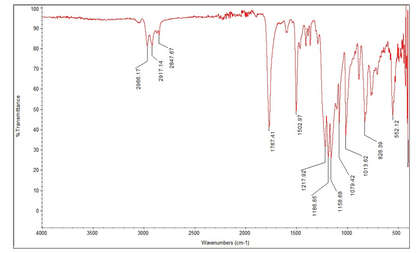
Results

Our preliminary studies focus on the challenge presented by the E-waste plastics. Specifically, a plastic from a Lenovo ThinkCentre M73 component.

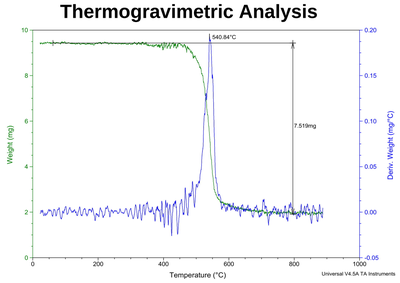




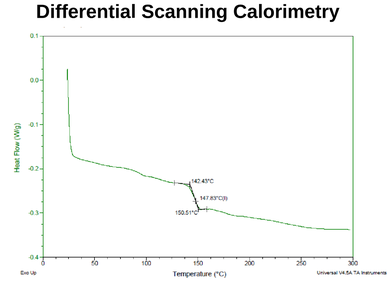
IR-Spectrum



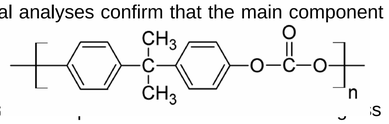
Thermogravimetric Analysis



Differential Scanning Calorimetry



- The infrared, IR, spectrum and the thermal analyses confirm that the main component of our plastic is a polycarbonate polymer.



- The polymeric material has a decompos transition temperature of 147.43 ° C.

Discussions and Conclusion

Regulations regarding the treatment of E-waste in the US are still in a developmental stage compared to Europe. In fact, some states do not have any E-waste recycling policy implemented. Fortunately, the current employed techniques for E-waste treatment are in right direction by implementing some of the 12 principles of green chemistry.

One of the main challenges in chemical recycling of E-waste is their polymeric compositions due to their complexity. we suggest further exploration of techniques such as Microwave assisted pyrolysis (MAP) as alternative due to its ability to save time and energy, and its concomitant cleaner chemical reaction conditions.