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Advancements in Biodegradable Printed Circuit Boards: Review of Material Properties, Fabrication Methods, Applications and Challenges

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Abstract
As electronic waste poses environmental challenges, exploring eco-friendly alternatives becomes imperative. In this review, the introduction reveals the disposal problem of existing printed circuit boards (PCBs) and the potential impacts of implementing biodegradable PCBs towards the United Nations Sustainable Development Goals. Various biodegradable materials, including polylactic acid, cellulose/cellulose acetate, silk proteins, gelatin, polyvinyl alcohol, mycelium, and wood, were evaluated for their properties and suitability in PCB manufacturing. Each material is scrutinised for its suitability in creating environmentally friendly circuit boards. The study meticulously analyses these biodegradable PCBs' electrical, mechanical, thermal and decomposition properties, providing insights into their performance under various conditions. The article also explores different fabrication methods and their advantages and limitations for manufacturing biodegradable PCBs. Solvent and non-solvent based decomposition of the biodegradable PCBs were revealed. The research outcome on a balance between hygroscopic property and degradability of biodegradable PCBs is revealed. The narrative extends to encompass the challenges and issues associated with the Design-for-Manufacturing processes and life cycle assessment of biodegradable PCBs, shedding light on potential hurdles and areas for improvement. The article concludes with a forward-looking perspective on the future of biodegradable printed circuit boards, environmentally friendly fire-retardants, a proposal for alternative standards for biodegradable PCBs, and their increasing role in sustainable electronics.

Author Keywords
Biodegradable materials; Decomposition; Fire-retardant board; Printed circuit board; Sustainability

Index Keywords
Fabrication, Life cycle, Printed circuit boards, Timing circuits, Wood; Biodegradable material, Cellulose acetates, Eco-friendly, Electronics wastes, Environmental challenges, Fabrication method, Fire-retardant board, Potential impacts, Silk proteins, United Nations; Sustainable development; Circuit Boards, Construction, Life Cycle, Review, Solvents, United Nations, Wood

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