

The brittleness of polylactic acid (PLA) can be improved through several strategies:

1. **Plasticization:** Adding plasticizers can increase the flexibility of PLA, thereby reducing its brittleness. Common plasticizers include glycerol, citrate ester, polyethylene glycol, and oligomeric lactic acid (reference\_156.pdf, page 1051).
2. **Copolymerization:** This involves creating copolymers with other monomers to enhance the toughness of PLA. By altering the polymer structure, copolymerization can improve the mechanical properties of PLA (reference\_156.pdf, page 1051).
3. **Melt Blending with Flexible Polymers or Rubbers:** Blending PLA with other polymers or rubbers can enhance its impact strength and reduce brittleness. This approach has been emphasized as a particularly effective method for toughening PLA (reference\_156.pdf, page 1051).
4. **Reactive Blending:** This is a specific type of melt blending that involves chemical reactions during the blending process to form new bonds, which can significantly enhance the impact strength and toughness of PLA (reference\_156.pdf, page 1051).
5. **Addition of Rigid Fillers:** Incorporating rigid fillers into PLA can improve its mechanical properties, including toughness (reference\_156.pdf, page 1051).

These methods focus on modifying the composition and morphology of PLA to achieve a balance between strength and flexibility, thus addressing its inherent brittleness.