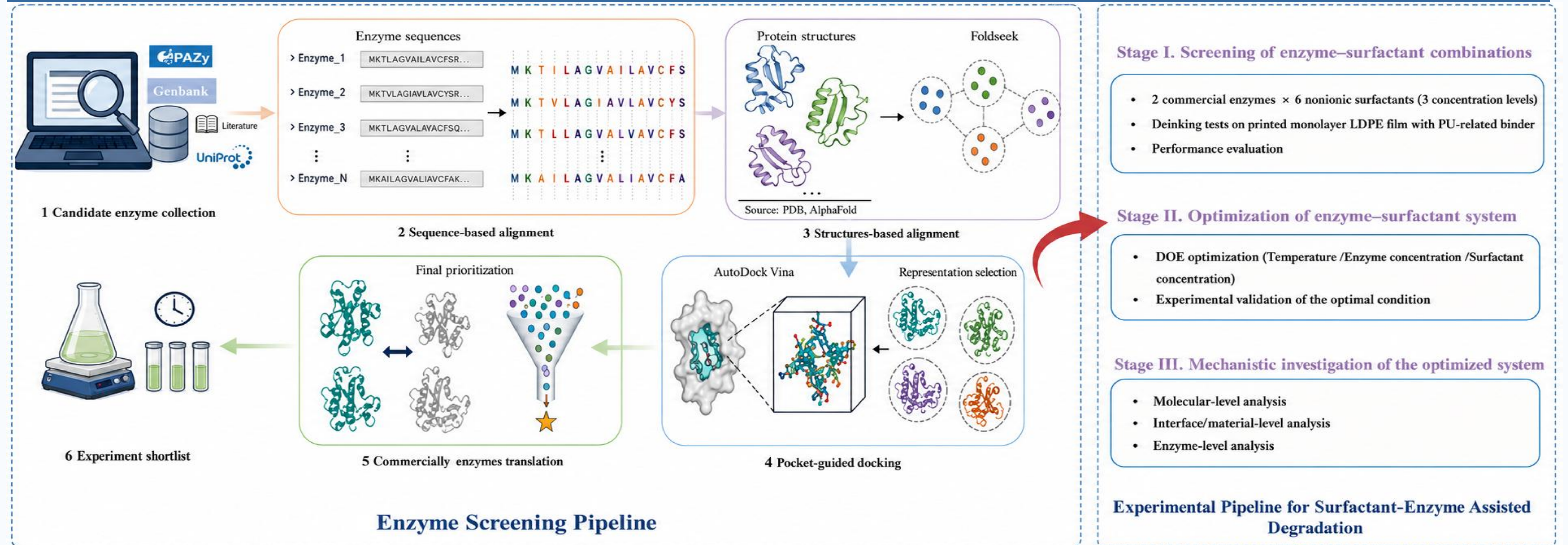




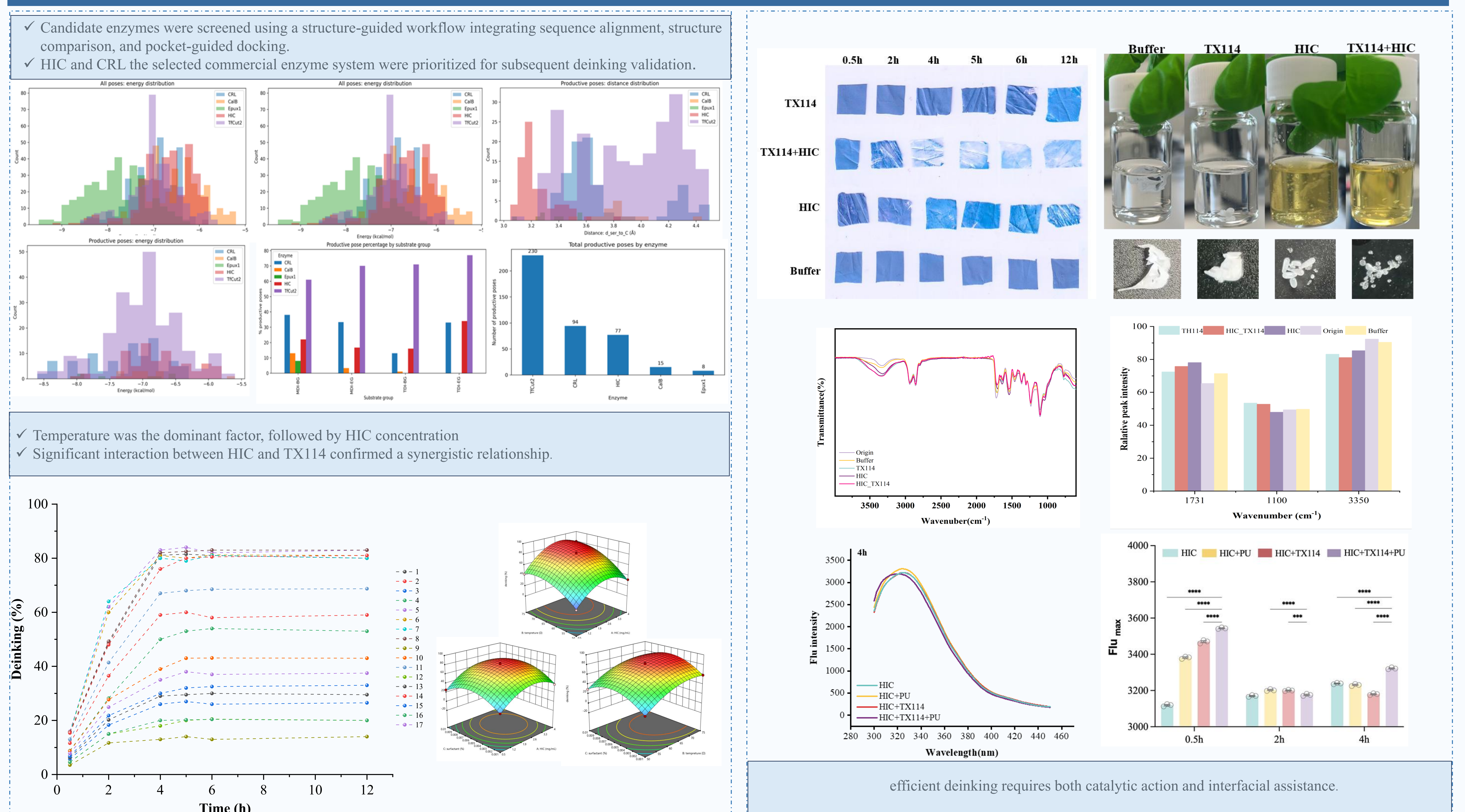
INTRODUCTION

For printed plastic films, the quality of recycled material is often constrained by the persistence of residual inks and binder-related layers. From an industrial perspective, this makes deinking relevant not only as a cleaning step, but also as a potential route to improve the usability and value retention of recycled plastics within circular material systems. While current deinking technologies rely predominantly on washing, surfactants, solvents, or chemical reagents, selective biocatalytic approaches remain less investigated for plastic films. In this work, we integrate structure-guided enzyme prioritization, experimental validation, and surfactant-assisted processing to examine enzyme-enabled deinking of printed monolayer plastic films. The study focuses on polyurethane-related binder structures as a target for selective weakening, with the broader aim of supporting milder and more selective deinking concepts for future plastic film recycling.

MATERIALS AND METHODS



RESULTS



CONCLUSION

- Structure-guided screening successfully identified PU-relevant enzyme candidates and supported the selection of commercially accessible enzymes for validation
- HIC + TX114 showed the best deinking performance, indicating a clear synergistic effect compared with HIC alone or TX114 alone
- Mechanistic results suggested that TX114 mainly improved interfacial accessibility and enzyme–substrate contact, rather than acting as the primary degrading agent by itself
- This study demonstrates a selective enzyme–surfactant strategy for deinking printed monolayer plastic films and provides a basis for improving their recyclability