

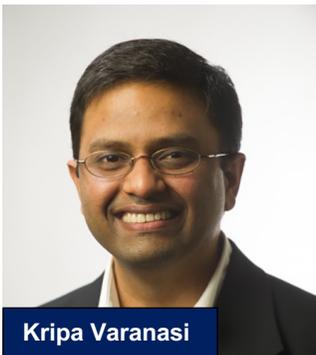


Fruit-peel-inspired Biodegradable Packaging Platform

Project Overview

What are biodegradable film solutions that can act as an impermeable barrier?

As human society becomes accustomed to the convenience that plastic products bring, the accompanying waste generated is increasingly overwhelming. In the United States, three-fourths of plastic waste goes to landfills, and it does not degrade for decades. Among plastic waste, packaging is the highest contributor, as plastic packaging is often single use. A significant portion of such waste ends in the ocean, and by 2050, estimates suggest that there will be more plastic in the ocean than fish by weight. In addition, production and disposal of plastics are often energy intensive.



The team, led by Professor Kripa Varanasi (Mechanical Engineering), Edmond Lam (Postdoctoral Fellow), and Shreya Agarwal (Graduate Student), aims to achieve full biodegradability for circularity in packaging solutions, while also uniquely maintaining a gas and water vapor barrier. They take inspiration from nature, where the peels of fruit provide intrinsic protection, and are composed of a structural layer (for rigidity) and a lipid layer (for selective gas permeation). Many eco-friendly commercial packaging solutions exist, but these products do not meet performance standards on permeability.

A critical feature of packaging is to retain the quality of its contents. Blocking oxygen and water vapor, for example, is crucial to maintaining the freshness of food over long periods of time. The research team has taken inspiration from fruit peels to create structures of biomimicry.



The project aligns closely with the MCSC's Circularity pathway.

Findings & Outcomes

A biodegradable packaging film that acts as an impermeable barrier.

The team has successfully fabricated a film out of completely natural materials with a simple process, the details of which are under peer review and will be published soon. The film is fully biodegradable, and hydrophobic, crucial in blocking water vapor (Figure 1).

Recent developments in biodegradable packaging pay little attention to permeability, despite its importance in the preservation of perishable goods. To quantify the performance of the films, the team constructed a permeation testing setup (Figure 2).

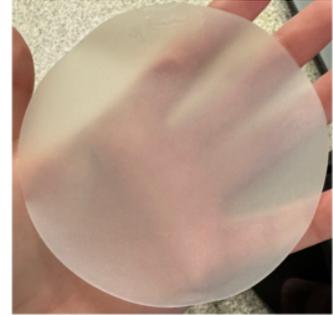


Figure 1: Packaging film prototype

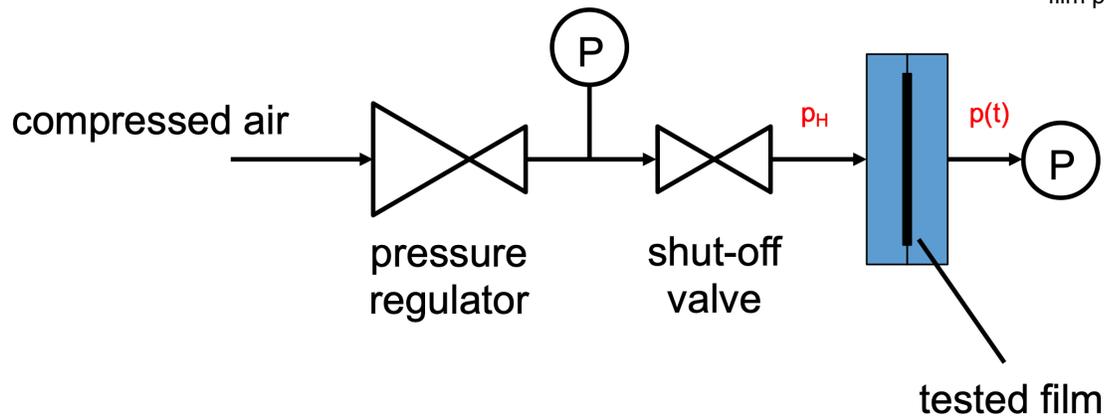


Figure 2: Permeation setup. Compressed air at high pressure is specified as the source and the pressure increase across the film is measured over time.

The team compared the performance of their prototype with commercial selections, including unbleached wax paper, Reynolds wrap (LDPE), nonstick parchment paper, beeswax paper, and Glad Press'nSeal. The performance comparison is shown in Figure 3. In the tested timeframe, there is no measured pressure increase across the team's films, whereas the increase of commercial selections occurred orders of magnitude earlier.

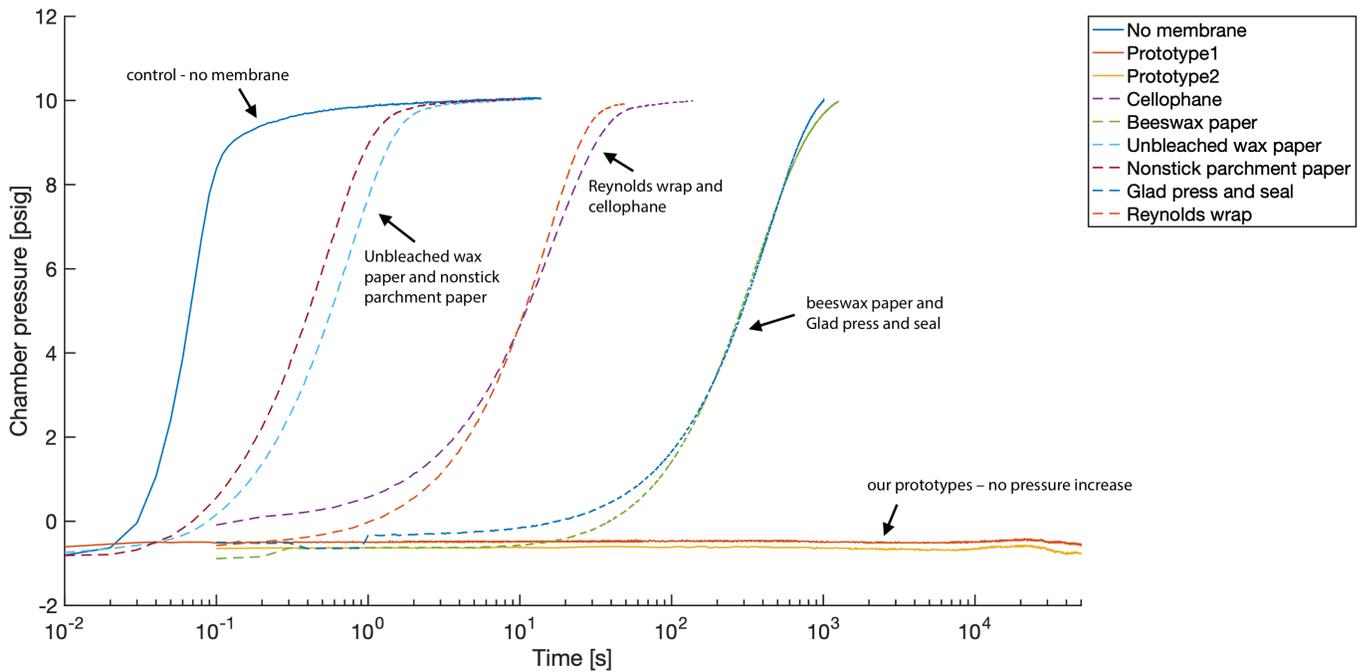


Figure 3: Performance of the prototype. The later the pressure increase, the better the performance.

Opportunities for Implementation

The researchers envision many applications for the new material, either as a standalone film or attached to existing products as a coating. It could also act as a platform to impart other properties such as antimicrobial features, for example, in single-use medical devices. As the researchers further explore and fine tune the required permeability characteristics, there will be opportunities for companies to pilot the material in a range of applications with different performance requirements.