Mosquito Bite Prevention through Graphene Barrier Layers

Cintia J Castilho, Muchun Liu, Robert H. Hurt

Graphene-enhanced fabrics are being explored in wearable technologies for environmental sensing, biomonitoring, UV protection, body heating, energy storage, ballistic protection, flame resistance, and chemical toxicant rejection. An unexplored application area for graphene-enhanced smart fabrics is protection against infectious diseases. The mosquito is the primary vector for infectious diseases that include malaria, yellow fever, dengue fever, and the Zika virus, and is thus classified as the deadliest organism on the planet. Graphene films are known to be effective barrier layers for molecular penetration, and we hypothesized they could also be engineered to serve as barrier layers in light fabrics to prevent mosquito biting, but there is no direct data on this function in the current literature.

The present study assesses this hypothesis using a combination of live mosquito experiments on human skin and mechanical penetration tests. We show that 1-um-thick graphene oxide (GO) and reduced graphene oxide (rGO) films in the dry state are highly effective at suppressing the biting behavior of *Aedes Egypti*, the yellow fever mosquito. Behavioral assays suggest the primary mechanism is molecular masking - a permeation barrier effect that prevents *Aedes* from sensing underlying skin-associated chemical attractants such as carbon dioxide. When wetted with water or human sweat as an attractant, rGO films continue to protect through puncture resistance that prevents penetration of the mosquito fascicle (a physical barrier effect), while unreduced GO films convert to mechanically soft hydrogels with low critical penetration forces and become non-protective.