A Novel Method for Identifying Pollen Allergens Using Chemically Modified Graphene

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One in four people is affected by pollen allergies, experiencing symptoms from allergic rhinitis to life-threatening anaphylactic shocks, and they heavily rely on up-to-date pollen counts in their area. However, current optical imaging and manual detection methods are slow, labor-intensive, and lack species-level specificity, putting pollen patients at great risk of pollen exposure. To address this, this study developed a graphene-based biosensor for rapid, selective detection of pollen type and concentration via antibody–antigen binding and resistivity measurement. The graphene surface was functionalized with organic linker PBASE to immobilize specific IgG antibodies; successful modification was confirmed via AFM and SEM. The capture of pollen proteins introduces a doping effect, causing a measurable change in graphene's electrical resistance. Graphene's resistance was monitored through a four-wire electrode configuration to eliminate contact resistance, and sensing ability was validated via Cyclic Voltammetry (CV). The device demonstrated strong specificity, supported by fifteen resistance measurements with high statistical evidence(P=0.00063). An exponential relationship (y=0.594e^-239.3x) was derived by fitting resistivity change against varying specific antigen concentrations, with a limit of detection down to ng/mL range for ragweed allergen. CV tests indicated that antibody-antigen binding stabilized in approximately 200 seconds. Integrated into a pollen station, this biosensor achieves accurate, real-time, and high-specificity detection of pollen types and concentrations. This research is scalable for public health monitoring and could be adapted to detect human allergies by pre-modifying pollen antigens onto the graphene surface in the future.

Awards Won:
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