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KECENDERUNGAN LOKALISASI ANDERSON DAN SIFAT ELEKTRONIK-OPTIK DI SISTEM TWISTED BILAYER GRAPHENE
AMBIPOLAR-30Â°: KAJIAN TIGHT-BINDING TIME PROPAGATION TROTTERâ€“SUZUKI
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INTISARI

Lokalisasi Anderson merupakan fenomena kuantum yang muncul akibat keberadaan *disorder* dan menyebabkan elektron mengalami lokalisasi. Penelitian ini mengkaji pengaruh *Gaussian vacancy disorder* terhadap sifat elektronik, lokalisasi elektron, dan konduktivitas optik pada sistem *twisted bilayer graphene* (TBG) 30° terdoping boron dan nitrogen menggunakan metode *tight-binding* berbasis *time-dependent Schrödinger equation* (TDSE) dengan skema Trotter–Suzuki. *Disorder* dimodelkan dalam bentuk *noncorrelated disorder* dan *correlated disorder* dengan konsentrasi *vacancy* hingga 10%. Hasil perhitungan menunjukkan bahwa peningkatan konsentrasi *vacancy* menyebabkan penurunan *density of states* (DOS), dengan pengaruh yang lebih kuat pada *noncorrelated disorder*. Analisis *inverse participation ratio* (IPR) menunjukkan terbentuknya keadaan elektronik terlokalisasi pada kedua jenis *disorder*, dengan tingkat lokalisasi yang lebih tinggi pada sistem bilayer dibandingkan monolayer. Hasil konduktivitas optik menunjukkan bahwa *noncorrelated disorder* menghasilkan perubahan amplitudo spektrum yang lebih besar dibandingkan *correlated disorder*, sementara posisi puncak utama tetap berada pada energi sekitar 5,2 eV. Meskipun terjadi penurunan DOS dan peningkatan lokalisasi elektron, DOS di sekitar energi Fermi tetap bernilai berhingga dan tidak ditemukan *optical gap*, sehingga sistem masih mempertahankan karakter metalik dan belum mengalami transisi *metal–insulator*. Hasil penelitian menunjukkan bahwa distribusi spasial *vacancy* berperan penting dalam menentukan sifat elektronik, lokalisasi elektron, dan respons optik sistem, serta mengindikasikan munculnya karakteristik lokalisasi Anderson pada sistem TBG 30° terdoping boron dan nitrogen.

Kata kunci: Lokalisasi Anderson, *twisted bilayer graphene* 30°, *Gaussian vacancy disorder*, *density of states*, *inverse participation ratio*, konduktivitas optik.

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ABSTRAK

Anderson localization is a quantum phenomenon induced by disorder that leads to the localization of electronic states. This study investigates the effect of Gaussian vacancy disorder on the electronic properties, electron localization, and optical conductivity of boron- and nitrogen-doped 30° twisted bilayer graphene (TBG) using a tight-binding method based on the time-dependent Schrödinger equation (TDSE) with the Trotter–Suzuki scheme. The disorder was modeled as both noncorrelated and correlated vacancy distributions with vacancy concentrations ranging from 0% to 50%. The results show that increasing vacancy concentration reduces the density of states (DOS), with a stronger effect observed for noncorrelated disorder than for correlated disorder. Analysis of the inverse participation ratio (IPR) reveals the emergence of localized electronic states in both disorder types, with stronger localization in the bilayer system compared to the monolayer system. Optical conductivity calculations indicate that noncorrelated disorder produces more pronounced changes in spectral amplitude than correlated disorder, while the main conductivity peak remains located at approximately 2.6 eV. Although DOS decreases and electron localization becomes stronger with increasing vacancy concentration, the DOS around the Fermi energy remains finite and no optical gap is observed. These results indicate that the system retains its metallic character and does not undergo a metal–insulator transition within the studied disorder range. Overall, the spatial distribution of vacancies plays a crucial role in determining the electronic properties, electron localization, and optical response of the system, while also indicating the emergence of Anderson localization characteristics in boron- and nitrogen-doped 30° twisted bilayer graphene.

Keywords: *Anderson localization, twisted bilayer graphene 30°, Gaussian vacancy disorder, density of states, inverse participation ratio, optical conductivity*