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Effects of Layer Stacking on the Combination Raman Modes in Graphene RAHUL RAO, Air force research laboratory, RAMAKRISHNA PODILA, Clemson University, RYUICHI TSUCHIKAWA, JYOTI KATOCH, DEREK TISHLER, University of Central Florida, APPARAO RAO, Clemson University, MASA ISHIGAMI, University of Central Florida — We have observed new combination modes in the range from $1650 - 2300 \text{ cm}^{-1}$ in single-(SLG), bi-, few-layer and incommensurate bilayer graphene (IBLG) on silicon dioxide substrates. The M band at $\sim 1750 \text{ cm}^{-1}$ is suppressed for both SLG and IBLG. A peak at $\sim 1860 \text{ cm}^{-1}$ (iTALO⁻) is observed due to a combination of the iTA and LO phonons. The intensity of this peak decreases with increasing number of layers and this peak is absent in bulk graphite. Two previously unidentified modes at $\sim 1880 \text{ cm}^{-1}$ (iTALO⁺) and $\sim 2220 \text{ cm}^{-1}$ (iTOTA) in SLG are tentatively assigned as combination modes around the K point of the graphene Brillouin zone. The peak frequencies of the iTALO⁺ (iTOTA) modes are observed to increase (decrease) linearly with increasing graphene layers.

Rahul Rao
Air force research laboratory

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