Electronic Supplementary Information (ESI)

The normal mode variations for different aspect ratios in the BLGSs are investigated. In general, a resonator using graphene sheets takes a rectangular shape with various aspect ratios due to the difficulty of manufacturing graphene sheets and their reliability in other devices. Therefore, it is worthwhile to study the effect of aspect ratio on the vibration characteristics of BLGSs. The aspect ratio is calculated as 'a' over 'b'. For convenience, we fixed the 'b' value as 45.44 Å but modulated the 'a' value from 12.30 to 91 Å, which corresponds to aspect ratios ranging from 0.27 to 2.00. Natural frequencies for various aspect ratios (a/b) are plotted over the first ten modes in Fig. S1. As the mode becomes higher, the natural frequency also increases, but is highly sensitive the aspect ratio. At the tenth mode, the natural frequency of graphene with an aspect ratio of 0.27 increases up to 1.11 THz, which is almost 115% higher than the natural frequency for an aspect ratio of 2.00. From a mathematical point of view, a system with more degrees of freedom (DOFs), represented by a higher aspect ratio in this context, tends to yield a denser frequency profile.

In contrast, the fundamental frequency at the first mode converges at 230 GHz regardless of the aspect ratio, and its corresponding mode shape remains a half sine. In other words, the fundamental frequency of the BLGS is insensitive to the aspect ratio, a result that is in good agreement with the literature.[31] The size sensitivity of fundamental BLGS frequencies for different aspect ratios between 0.50 and 2.00 was also examined (Fig. S2). As expected, the fundamental frequency is also insensitive to the aspect ratio when the size of the BLGS varies. The difference in frequency is less than 7% over the entire range of tested lengths.

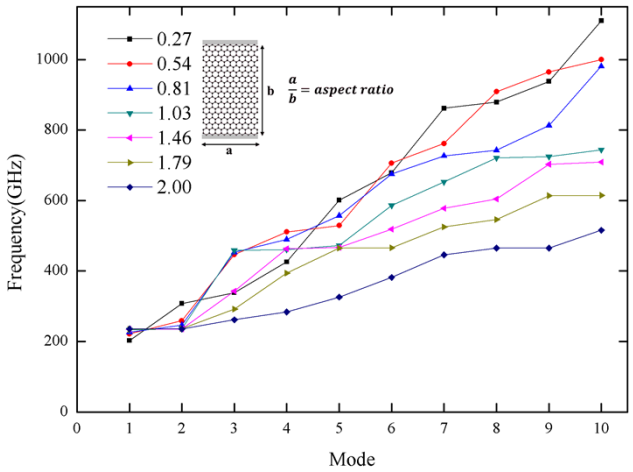

Fig. S1 Aspect ratio dependence of the natural frequency for BLGSs with b = 45.44Å and a range of a = 12.30 to 91Å, corresponding to aspect ratios ranging from 0.27 to 2.0. The inset shows how the aspect ratio is determined.

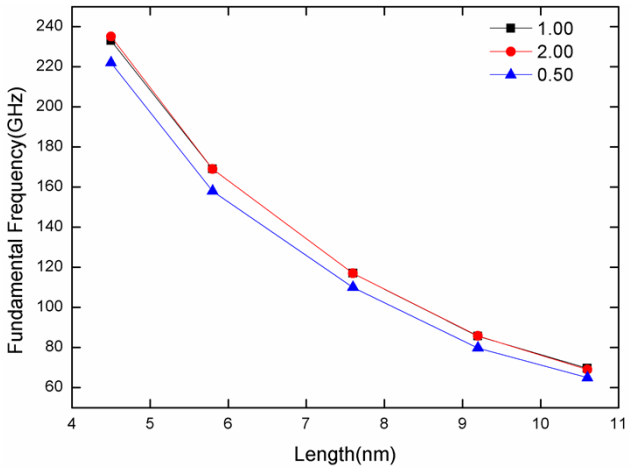

Fig. S2 Fundamental frequencies versus its length of BLGS with difference aspect ratio from 0.50 to 2.00.

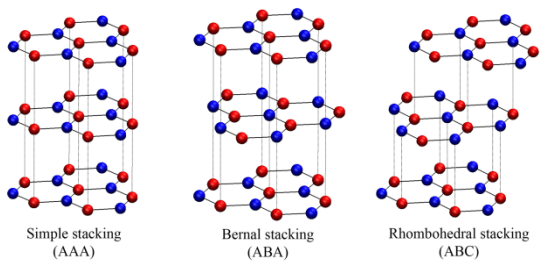

Fig. S3 Atomic structure of FLGSs. For simple stacking (left figure), all layers are stacked exactly parallel to each other. In Bernal stacking (center figure), only the third (top) layer is exactly parallel to the first (bottom) layer. In rhombohedral stacking (right figure), the third (top) layer is shifted by a unit distance (1.42 Å) from the first (bottom) layer.