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Effect of UV light-induced nitrogen doping on the field effect transistor characteristics of graphene

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According to the phenomenological model proposed by Lucchese *et al.*[1], there are two regions inside and outside a single defect: a structurally disordered region (S-region), and a Raman-active region (A-region) as shown in Fig. S1a. In the S-region, the honeycomb network is totally broken, which does not contribute to the D band. The A-region lies around the S-region. The selection rules for the A_{1g} vibrational mode is broken by defects in the A-region, leading to the evolution of the D band. As the intensity of the D band is proportional to the area of the A-regions, the I_D/I_G can be written as

$$I_D/I_G = C(\pi r_a^2 - \pi r_s^2) = \pi r_a'(2r_s + r_a'),$$

where C is a proportional constant, and r_a, r_s, r_a' are the length scales shown in Fig. S1a. In the case of ion-bombardment, r_s and r_a' are ~1 nm and ~2 nm, respectively[1]. In contrast to the defects caused by ion-bombardment, r_s is even smaller for an sp^3 carbon atom as a bonding structurally breaks only one carbon atom[2].(Fig. S1b) Assuming that r_a' is constant regardless of the type of defects, the area of the A-regions for sp^3 carbon atoms is estimated to be smaller compared to the defects caused by ion-bombardment.(Fig. S1c) Considering that defects caused by UV-irradiation in NH_3 are sp^3-like bonds and amino groups, it is reasonable that the defect density judged from I_D/I_G is vastly underestimated.

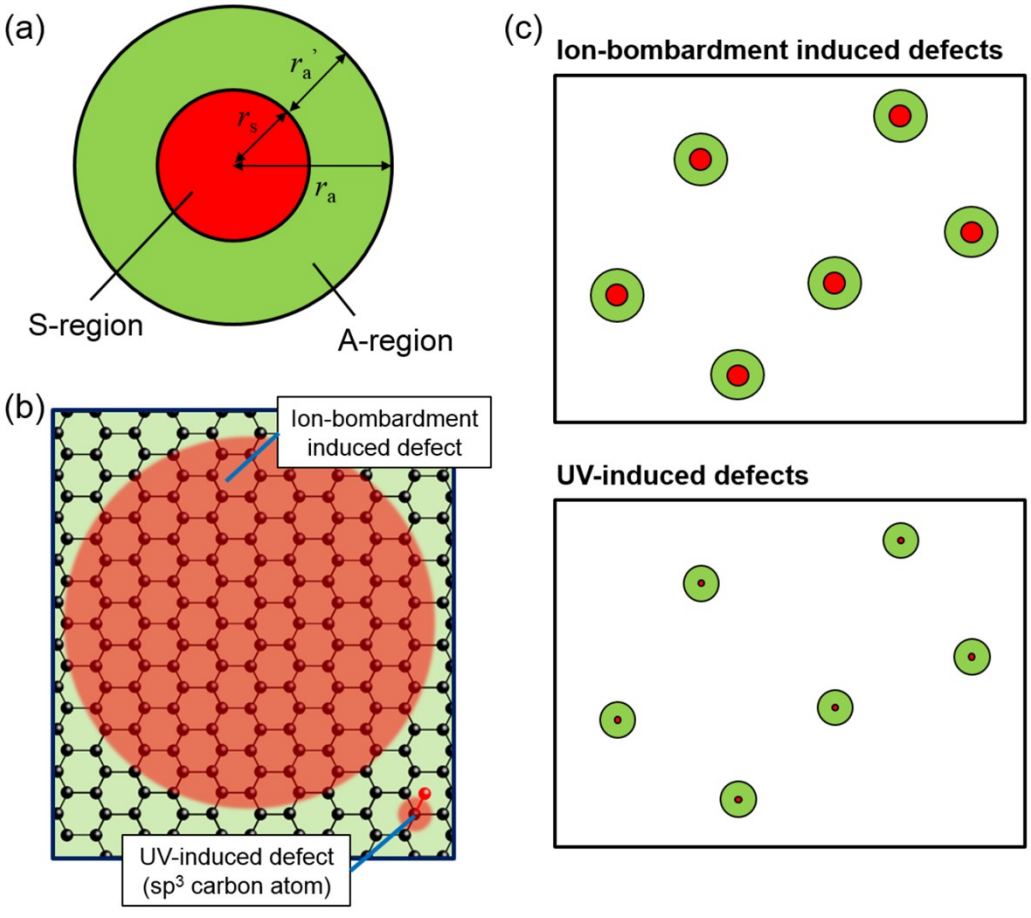

Figure S1. (a) Model for a single defect. Definition of S-region, A-region, r_s, r_a and r_a'. (b) Comparison of the defects caused by ion-bombardment and UV-irradiation. (c) Comparison of the defects distributed with the same defect density.

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