Electronic Supplementary Material (ESI) for Nanoscale.

Coupling double flat bands in a quadrangular-star lattice

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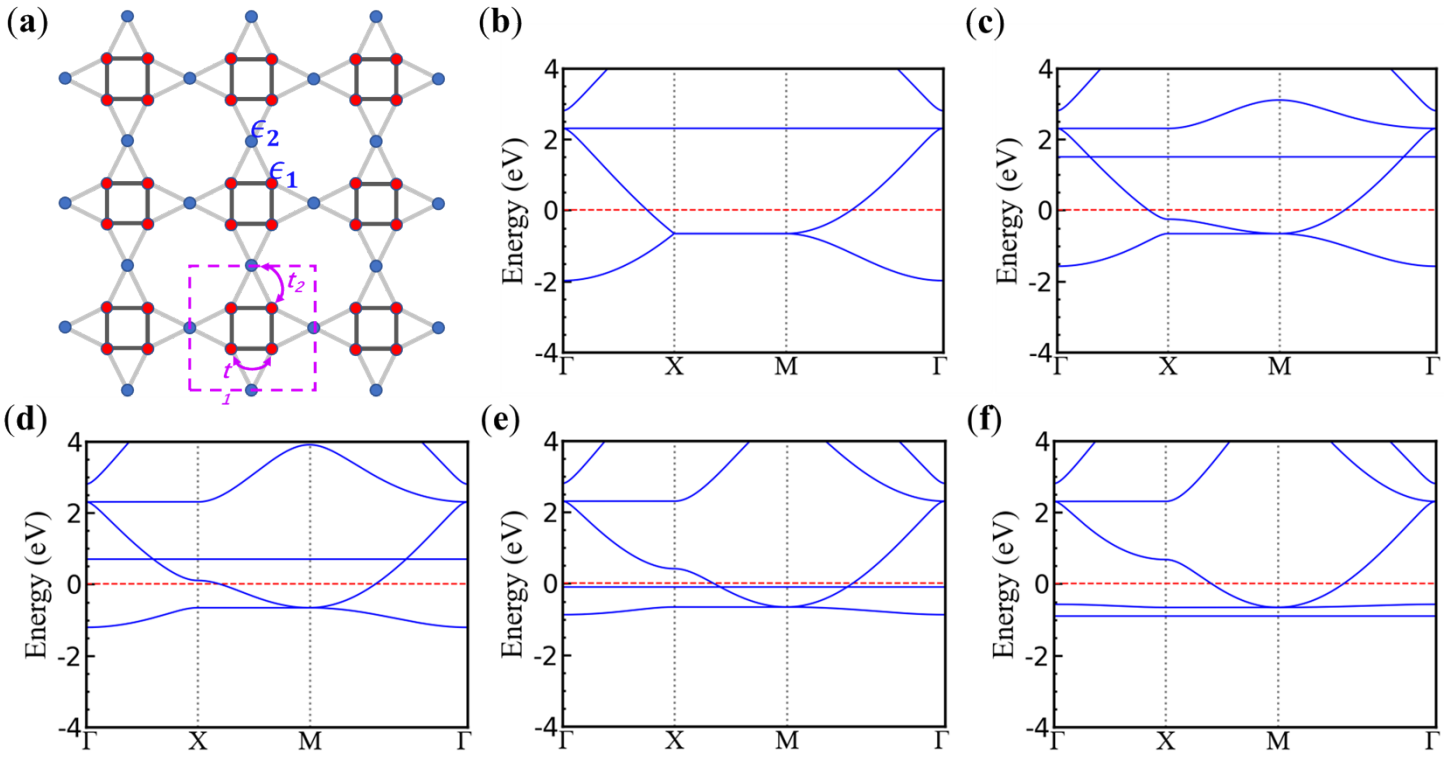

FIG. S1. (a) A QSL, in which the primitive unit cell is shown in the dotted box. The site energies of the red and blue lattices are marked as ϵ_1 and ϵ_2, t_1 and t_2 represent the hopping energies between red lattices and between red and blue lattices, respectively. Based on the band structure of tight-binding model in Eq. (1) with parameters $\epsilon_1 = 2.8$, $\epsilon_2 = 2.3$, and (b) t_1=0 eV, t_2=1.6 eV; (c) $t_1 = 0.4$ eV, $t_2 = 1.6$ eV; (d) $t_1 = 0.6$ eV, $t_2 = 1.6$ eV; (e) $t_1 = 1.2$ eV, $t_2 = 1.6$ eV; (f) $t_1 = 1.6$ eV, $t_2 = 1.6$ eV.

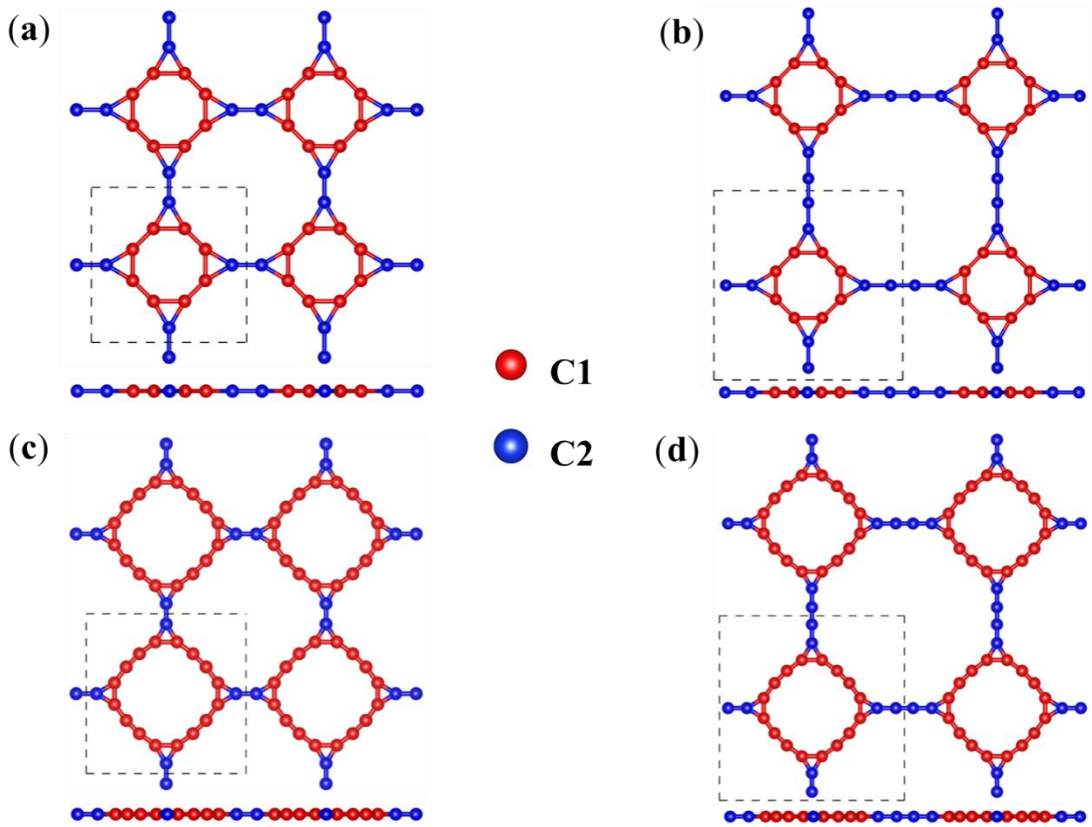

FIG. S2. The top view and side views of CQSL-12 (a), CQSL-16 (b), CQSL-20 (c) and CQSL24 (d), where their primitive cells are shown in the dashed boxes.

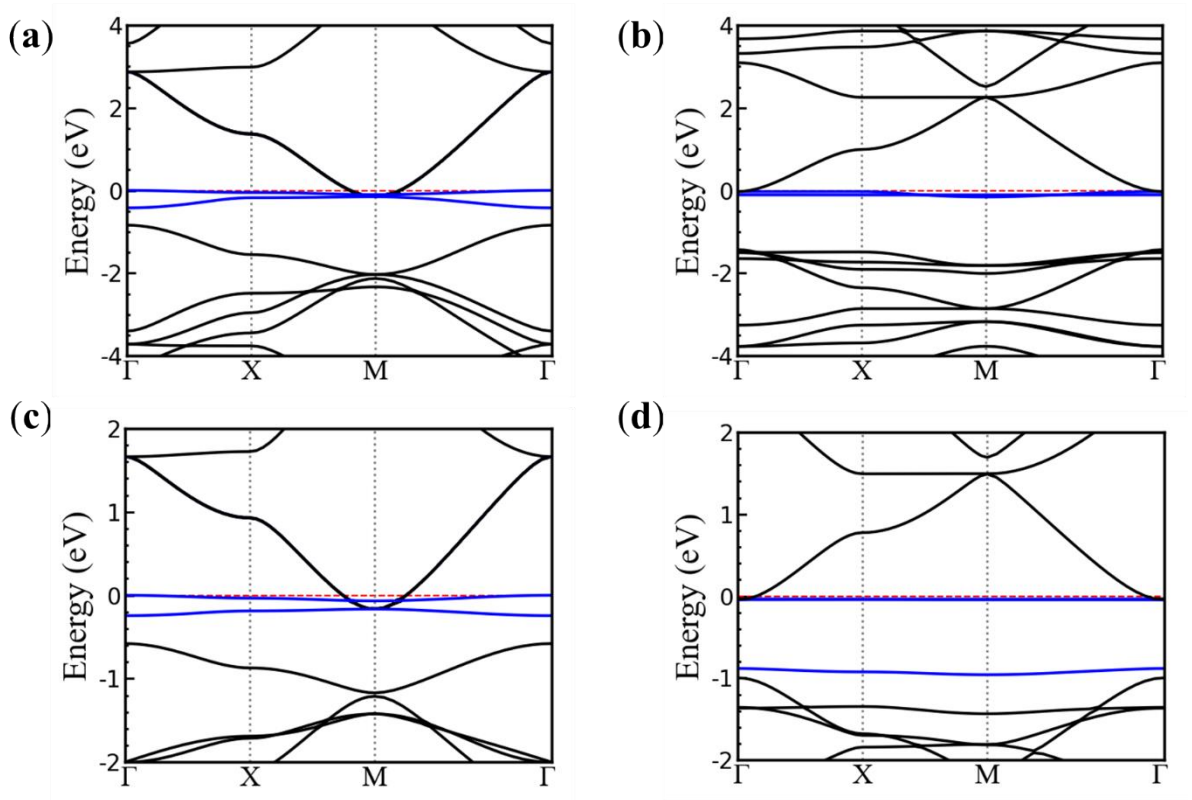

FIG. S3. Band structures of CQSL-12 (a), CQSL-16 (b), CQSL-20 (c) and CQSL-24 (d).

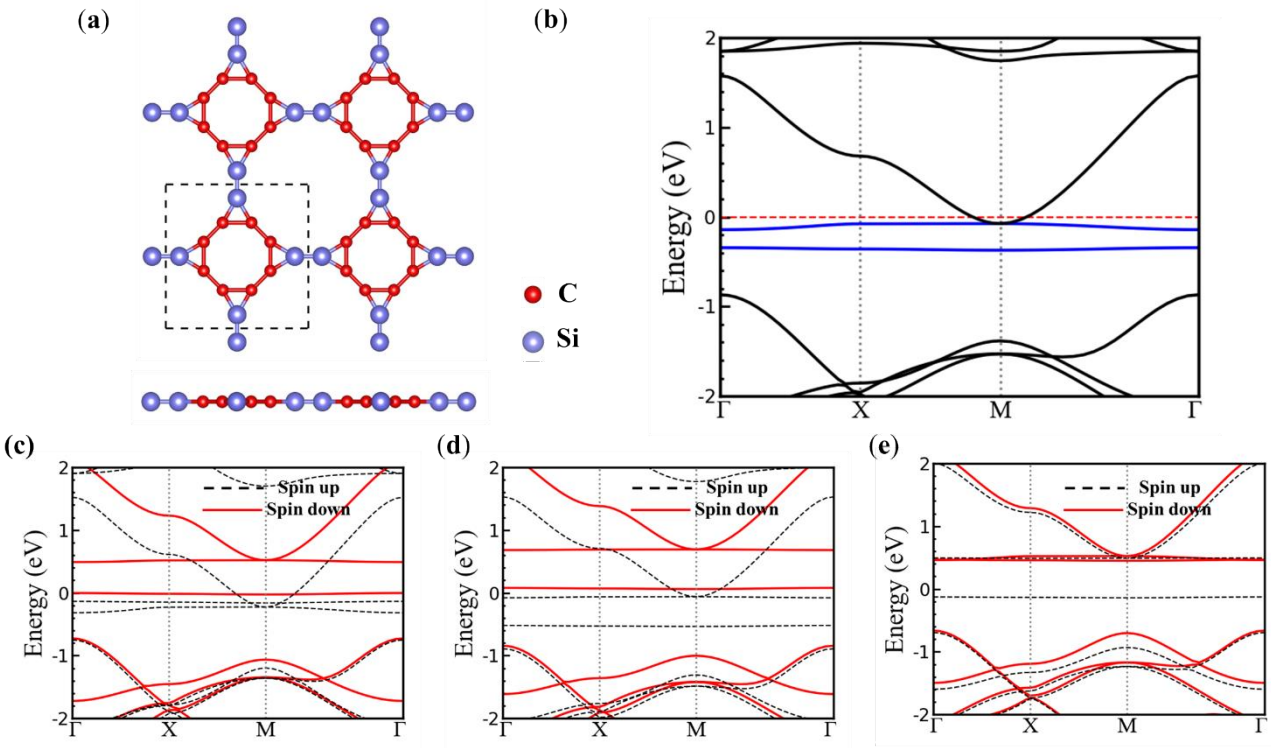

FIG. S4. (a) Atomic structure of CSiQSL-12, where the carbon dimers in CQSL-12 are replaced by silicon atoms. (b) Band structure of CSiQSL-12. Band structures of CSiQSL-12 in the case of one (c), two (d) and three (e) holes doping. The dashed and solid lines represent the spin-up and spin-down energy bands, respectively.

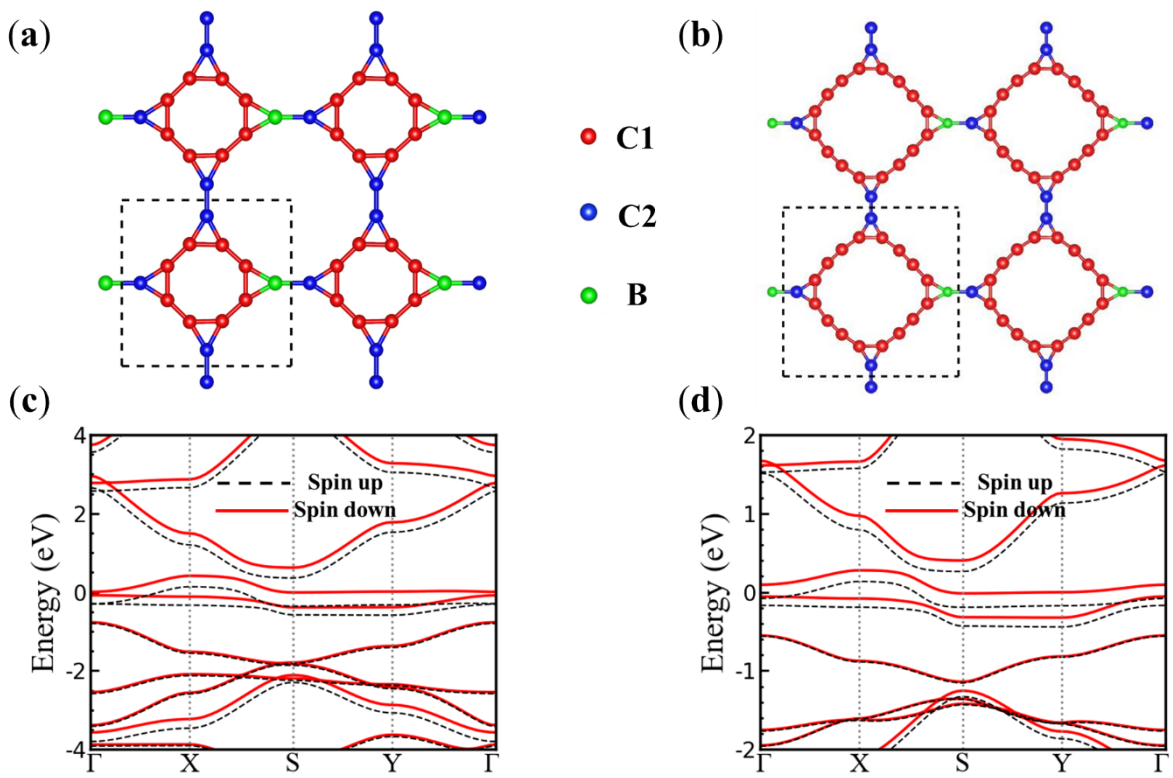

FIG. S5. Structure diagram of CBQSL-12 (a) and CBQSL-20 (b). The energy band structures of CBQSL-12 (c) and CBQSL-20 (d), where dotted and solid lines represent the spin up and spin down energy bands, respectively.

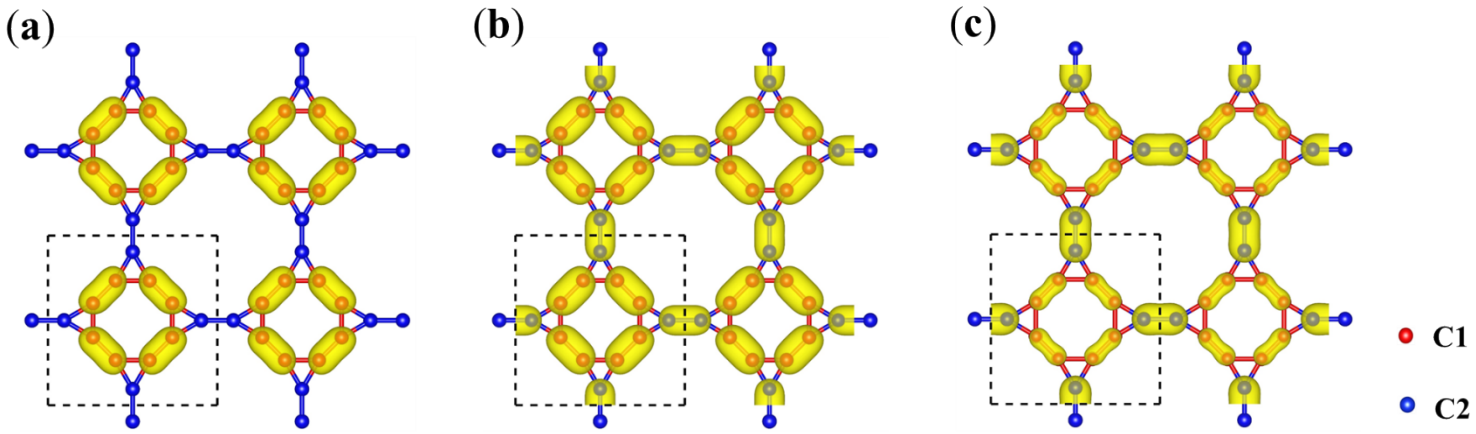

FIG. S6. The spin polarization density of QSL-12 doped with 1 (a), 2 (b), and 3 (c) holes. We set the isosurface level to 0.003 e/bohr^3.