

The van der Waals (vdW) interactions, or dispersion forces, are crucial in many chemical, physical and biological processes and received much attention from developers of density functional theory (DFT) methods. The most popular non-empirical DFT method for treating vdW interactions is the vdW density functional by Dion *et al.* (vdW-DF). Despite its success, vdW-DF is not accurate enough for many chemical applications. Here, we investigate two possible ways how to improve its accuracy. First, we reoptimize the only weakly specified parameter of vdW-DF for several semi-local functionals. On the S22 benchmark database set, we find that revPBE is the best performer, decreasing the error from 8.8% to 6.3%. Second, a system-specific but very accurate (~ 0.1 kcal/mol) DFT correction scheme is proposed for precise calculations of adsorbent–adsorbate interactions by combining vdW-DF and the empirical DFT/CC correction scheme. The new approach is applied to small molecules (CH_4 , CO_2 , H_2 , H_2O , N_2) interacting with a quartz surface and a lamella of UTL zeolite. The very high accuracy of the new scheme and its relatively easy use and numerical stability compared to the earlier DFT/CC scheme offer a straightforward solution for obtaining reliable predictions of adsorption energies.