We present a new all-electron self-consistent implementation of the GW approximation based on full-potential LMTO method. The dynamically screened Coloumb interaction $W$ is expended in a mixed basis which consist of two contributions, local atom-centered functions confined to muffin-tin spheres, and plane waves with the overlap to the local functions projected out. The former can include any of the core states; thus the core and valence states can be treated on an equal footing.

Non-self-consistent calculations applied to a wide variety of semiconductors and some metal oxides (MnO, NiO, CdO) show the following: (1) the fundamental gaps are systematically underestimated; (2) in the III-V semiconductors, there is a k-point dependence of the gap error, with errors largest at the X point; (3) the closed d shell level for materials containing Ga, In, Zn, Cd, and Hg is shifted downward relative to the LDA, but still the shift is underestimated. This contributes in part to the gap underestimate. (4) the effect of shallow cores on the gap, and also on the k dispersion in the gap, is significant.

A limited form of self-consistency is achieved by following iteration cycle: using eigenfunctions of the LDA Hamiltonian with an added self-energy term the next-iteration self-energy is calculated in GW approximation. The non-local and energy dependent self-energy term is then added to the LDA Hamiltonian and next iteration wave-functions and energies are obtained by diagonalization.

The CPU time of otherwise numerically prohibited SC GW simulations has been reduced by an order of magnitude utilizing the dispersion relations. The results obtained for band gaps of Si and MnO are in good agreement with the experimental values, noticeably better then results obtained in the non self-consistent GW and LDA approximations.

A preliminary calculation of the total energy using the Luttinger-Ward functional is presented for Si and Na. In both cases, the equilibrium lattice constants are in reasonable agreement with experiment.