CLAIMS

1. A shutter device, comprising a light blocking unit and a voice coil motor; wherein the voice coil motor comprises a permanent magnet module, a guide track assembly and a coil assembly; the coil assembly is arranged on the guide track assembly, and the permanent magnet module is adapted to produce a magnetic field in the guide track assembly; the light blocking unit comprises two shutter blades both connecting to the coil assembly; the coil assembly is configured to, when energized, produce a magnetic field having a direction same as or opposite to the direction of the magnetic field in the guide track assembly so that the coil assembly moves forward or backward along the guide track assembly to drive the two shutter blades to open or close; wherein a shaft-bearing assembly is arranged between the shutter blades and the coil assembly; the shaft-bearing assembly comprises a bearing seat, a shaft mounted on the bearing seat, bearings attached to the shaft and sleeves fitted over the bearings, and wherein the shutter blades are sheathed over the shaft and connected to the coil assembly.

2. The shutter device of claim 1, wherein the permanent magnet module comprises two permanent magnet sets arranged in symmetry, each containing two permanent magnets between which the guide track assembly is arranged, and wherein the coil assembly comprises two coils, each of which is connected to a corresponding one of the shutter blades and corresponds to a respective one of the permanent magnet sets.

3. The shutter device of claim 1 or 2, wherein the guide track assembly comprises an iron core.

4. The shutter device of claim 1 or 2, wherein the guide track assembly is curved or semi-circular.

5. The shutter device of claim 1, wherein the two shutter blades are hinged together like a pair of scissors, with an overlap therebetween in a closed configuration

of the shutter blades.

6. The shutter device of claim 1, wherein the shutter blades are implemented as aluminum blades.

7. The shutter device of claim 1, wherein the shutter blades have undergone a black anodizing surface treatment.

8. The shutter device of claim 1, further comprising a casing in which the voice coil motor and the light blocking unit are housed, the casing defining an aperture in positional correspondence with the light blocking unit.

9. The shutter device of claim 8, wherein the casing defines a cooling gas inlet for introducing compressed air for cooling the voice coil motor and the light blocking unit.

10. The shutter device of claim 8, wherein the shutter blades define a diameter that is greater than a diameter of the aperture.

11. The shutter device of claim 1, wherein the shaft matches with the bearings in transition fits, and the bearings match with the sleeves in transition fits.

12. The shutter device of claim 1, wherein the bearings are implemented as double deep groove ball bearings.

13. The shutter device of claim 1, further comprising position detectors mounted on the bearing seat and foil position sensors mounted on the sleeves at fixed positions with respect to the shutter blade.

14. The shutter device of claim 1, wherein each of the shutter blades has a center of gravity that is in vicinity of a center of the shaft and is closer to a curved edge of the shutter blade.

15. The shutter device of claim 1, wherein the permanent magnet module and the guide track assembly are both mounted and fixed to the bearing seat.

16. A method of controlling the shutter device of any one of claims 1 to 15, comprising:

determining an output force of the voice coil motor based on a size of a desired light spot; and

determining a current output from a control board to the coil assembly, based on the output force of the voice coil motor;

wherein the control board is configured to output, to the coil assembly, a forward current to accelerate movements of the shutter blades and a backward current to decelerate movements of the shutter blades so that the shutter blades can be opened and closed in a cycle consists of four phases: acceleration for opening, deceleration for opening, acceleration for closure and deceleration for closure, each lasting for a defined energizing time duration.

17. The method of claim 16, further comprising outputting by the control board, to the coil assembly, a current for keeping the shutter blade stationary, which is much lower than the forward and backward currents for accelerating and decelerating the movements of the shutter blades.

18. The method of claim 16, wherein determining the output force of the voice coil motor based on the size of the desired light spot comprises: determining an angular travel length for each of the shutter blades based on the size of the desired light spot; and based on the angular travel length, calculating a required force for driving the shutter blades during the opening/closing cycle and hence determining the output force of the voice coil motor.

19. The method of claim 16, further comprising: optimizing peaks of the current output from the control board to the coil assembly so that the shutter blades are controlled by an S-shaped speed profile.

20. A photolithography machine, comprising the shutter device as defined in any one of claims 1 to 15.

21. An exposure dose control method for use with the photolithography machine of claim 20, comprising: receiving an instruction indicative of an exposure

dose, based on which, an output force of the voice coil motor is determined; and based on the output force of the voice coil motor, determining an current output from the control board to the coil assembly and energizing time durations of the coil assembly for a single exposure dose control cycle consisting of actions of: acceleration for opening of the shutter device, under an effect of a forward current output by the control board to the coil assembly; subsequent to completion of the acceleration action, deceleration for opening of the shutter device, under an effect of a backward current output by the control board to the coil assembly; subsequent to completion of the deceleration action, standby of the shutter device, under an effect of a holding current output by the control board to the coil assembly; acceleration for closure of the shutter device, under an effect of a forward current output by the control board to the coil assembly in response to a closing instruction given upon the satisfaction of an time-energy criterion; and subsequent to completion of the acceleration action, deceleration for closure of the shutter device, under an effect of a backward current output by the control board to the coil assembly.