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Design of X-ray Target for a CNT-based high-Brightness Microfocus X-Ray Tube

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We present a theoretical design of the target for a high-brightness microfocus x-ray tube, which is based on carbon nanotubes (CNT) as electron source. This x-ray tube has the following specifications: brightness of 1 X 10^{11} ph/s-$mm^2 mrad^2$, spot size ~5 μm, and average x-ray energy of 20~40 keV. To meet the specifications, we optimized the design parameters of the target, such as configuration, material, thickness of the target as well as the required beam current, using the computer code MCNPX. Based upon the calculation of both the x-ray spectrum and intensity distribution, we chose a transmission type target geometry and molybdenum (Mo) as the target material with an optimum thickness of 7.2 μm. Since such a thin target should withstand vacuum pressure and localized thermal loading, therefore we also considered the structural stability and temperature distribution. According to the analytic calculation, the transmission Mo target itself could not withstand the vacuum pressure. As an alternate we backed the molybdenum target from rear side with 150 μm thick beryllium (Be) to strengthen the structure stability. The spectrum calculation with the backing configuration indicated a minute increase in required beam current. In addition, the calculation shows that the maximum temperature of the transmission target can be controlled within a stable-operation regime by forced air-convection cooling.