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Additive manufacturing of X-band RF cavities

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With increasing operational frequency (f_R), the size, weight, and power consumption of linear accelerators (Linacs) decrease, which is why e.g. X-band Linacs are attractive for industry, medicine, and science. However, a higher f_R also requires stricter manufacturing tolerances for the radio frequency cavities of the Linacs. Combined with the disadvantages of conventional cavity manufacturing processes, this leads to increased investment costs for high frequency Linacs. Various studies show that additive manufacturing (AM) has the potential to significantly reduce the cost of cavities while increasing performance. This work investigates, for the first time, whether laser powder bed fusion (PBF-LB/M) offers the geometric accuracy necessary for X-band cavity manufacturing. Eight 9.3 GHz side-coupled cavity prototypes, each comprising three unit cells, were fabricated from CuCrZr. The manufacturing accuracy of the prototypes was determined through optical and f_R measurements. Additionally, the quality factor and surface roughness were evaluated. The results demonstrate the potential of PBF-LB/M for the production of X-band cavities and therefore advanced Linac concepts.

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