Development of 1.3 GHz SRF cavities half cell machining process at RRCAT

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Abstract

Development of SRF cavity half cell machining has been taken up at RRCAT as part of its SRF cavity development program. Here we present the work done so far in the development of half cells machining process for single cell 1.3 GHz cavities. These cavities have been manufactured and tested under IIFC collaboration. The first two cavities reached a gradient of 21-23 MV/m and the next two cavities reached a gradient of 35-37 MV/m, thus approaching the results obtained by other labs. These results have validated cavity half-cell machining process developed for SRF cavities in so far as achieving accelerating gradient is concerned. We have designed and developed a new machining fixture and machined SRF cavity half cells successfully using this fixture. The fixture is used to machine half cell to required length and to make machining features at equator & iris for EB welding of half cells. The features for welding stiffening ring on the half cell are also machined in the same setting. With this new fixture the half cell machining is completed in two stages but the half cell is not removed from fixture during this process, thereby approaching the concept of machining all half cell features in single setting .With the initial available design of machining fixture, we could achieve parallelism of 0.2 to 0.3 mm between equator face and iris face, where as the parallelism requirement is 0.02 mm. Subsequently we designed & developed a new fixture based on a different concept and parallelism of 0.02mm was achieved repeatedly. Machining parameters, cutting speed, feed and depth of cut for turning of Niobium were established by trial and error. Unlike in conventional turning, the surface finish does not improve with increase in cutting speed in all the cases. For material like Niobium turning cutting speed as variable has the greatest influence on the tool life and tool BUE problem. Depth of cut and feed are also critical. We could achieve surface finish of better than 0.8 micron on all machined areas.