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# Copper full-seamless substrate cavity manufactured by hydroforming

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The general method for manufacturing superconducting accelerating cavities with an elliptical cell shape is to press-form niobium sheets into a bowl shape and join them together using electron beam welding (EBW). Research on manufacturing cavities at a low-cost using hydroforming instead of EBW has been achieved. Another research has been actively conducted in recent years to manufacture the cavity body from copper and coat niobium inside to develop superconductivity for reducing the cost of superconducting cavities. The purpose of this research is to manufacture a seamless cavity from a single copper tube. In 2023, through collaborative research with Neuron Japan Co. Ltd., we succeeded in prototyping a 1.3 GHz one-cell copper cavity. We tried forming a single tube into a hollow shape at once but found it difficult, so we devised a two-step forming process. Two kinds of dice are prepared and finished by hydroforming only. Copper has better formability than niobium, but there is no industrial application to expand such an enormous size by hydroforming. Here, it is necessary to increase the circumference by 2.4 times. In this process, the material is expanded significantly, so an elongation of the material is significant, but minimizing the wall thickness distribution is even more critical. So far, we have successfully manufactured more than ten cavities and confirmed high reproducibility. This study collaborated with CERN, and the two completed copper full-seamless cavities were coated with niobium inside using a magnetron sputtering at CERN. The thickness of the niobium film is approximately 5 μm. Afterward, RF tests were performed at KEK. The acceleration gradient attained CERN's target value of 12 MV/m at 4.27 K. The Q value was a little low. Also, at 1.85K, the maximum acceleration gradient of 15.7 MV/m was obtained. We got a good result for the first cavities.

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