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Jefferson Lab in the News

ILC Treatment of JLab Cavity Garners Exciting Result

HG-6 was electropolished with a recipe developed by ILC research and custom-tailored here at Jefferson Lab. Accelerator cavities for the ILC and Jefferson Lab's two accelerators are all similar in material and function.

For the last few years, Jefferson Lab staff members have used the lab's unique facilities to test various accelerator components for a proposed next-generation collider, the International Linear Collider. Reminiscent of a stack of doughnuts, accelerator components called cavities energize particles for use in experiments that explore the smallest bits of matter.

In preparing ILC cavities for tests at Jefferson lab, staffers have followed the state-of-the-art recipes developed here and by other research facilities. More importantly, they have spent time optimizing those recipes for improved results, directly benefiting the field of accelerator science. Now, an opportunistic test of an ILC recipe they've helped to develop shows that the work could one day benefit the lab's main accelerator, as well.

Charlie Reece, deputy director of the Jefferson Lab Institute for Superconducting Radio Frequency Science and Technology, singled out the cavity for the test. He says the cavity was a modified design of the standard JLab accelerator cavity, the so-called high-gradient design.

"The skill of cavity shape design has developed a lot since [the original cavities] were designed in 1983," he explains.

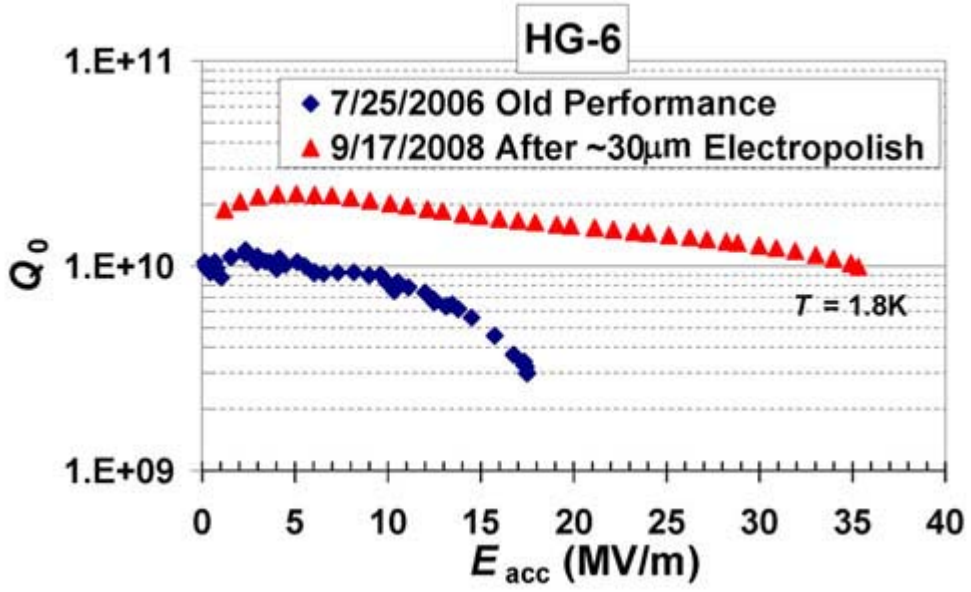
The cavity is part of a set of high-gradient cavities that had been constructed for use in the lab's next-generation test cryomodule, called Renascence. A cryomodule is a complete, modular section of the accelerator. Each cryomodule houses a string of eight cavities and associated equipment.

"This cryomodule was two or three years in development, and it was thought that the module might get used in

the Free-Electron Laser, which wanted the high-gradient cavities. So [the FEL] agreed to fund the fabrication of three additional high-gradient cavities," Reece remembers.

When plans changed, one of the three high-gradient cavities reverted to use as a test cavity. As usually happens with such cavities, it was put through its paces in various tests and between-test acid cleaning cycles.

The standard acid cleaning process, buffered chemical polish, followed by standard preparation and rigorous testing, proved punishing. As the test/cleaning cycle dragged on, the cavity's performance degraded. The cavity, designated HG-6, was no longer performing well enough to meet minimum specifications.



Before the ILC-style electropolish, the accelerating gradient of this Jefferson Lab accelerator cavity topped out near 17 megavolts per meter (MV/m), a measure of the cavity's ability to impart energy to electrons. After processing, the cavity's accelerating gradient jumped to 35 MV/m.

"The quality factor goes down. I interpret it to mean that the surface was getting progressively rougher," Reece says.

Rongli Geng, an ISRFST staff scientist, agrees. "After you apply a lot of buffered chemical polish, the performance is no longer good. You no longer meet the specification for operation."

The scientists wondered if a newer technique for processing cavities, specifically the electropolish technique being developed for ILC cavities, could smooth out the HG-6's interior surface enough to improve its performance. Unlike buffered chemical polish, electropolishing uses a jolt of electricity along with acid to chemically peel away a thin layer of surface material, leaving a new, smooth surface.

"We wanted to explore the benefit and figure out what effect a light EP would have on this cavity," Geng explains.

With the help of Curtis Crawford, an ISRFST visiting fellow, and Scott Williams, an ISRFST mechanical technician, Geng used the JLab version of the ILC cleaning and final preparation recipe on HG-6. The process included the electropolish procedure, followed by a high-pressure rinse and low-temperature bake of the cavity. He then subjected the cavity to the standard tests.

"The performance improved from 17 MV/m to 35 MV/m. Its performance more than doubled!" Geng exclaims. "This is really a remarkable testing result."

Now Reece and Geng are looking to the future. They expect that this and similar cavity processing methods will continue to raise performance standards of components for almost all superconducting radiofrequency technology-based accelerator projects.

"You can just apply the final touch to a cavity, by using the current state of the art at Jefferson Lab. It's very likely it's going to be a very minor increase in the cost. But we secure much better performance," Geng adds.

Further Reading

Reaching New Heights in Accelerator Technology (http://www.jlab.org/news/releases/2006/accelerator.html)
Jefferson Lab Cooks Up the Perfect Cavity (http://www.jlab.org/news/releases/2007/cavity.html)
JLab Scientist Develops Portrait of a Gremlin (http://www.jlab.org/news/articles/2008/gremlin.html)
JLab Supports International Linear Collider Cavity Development Work (http://www.jlab.org/news/articles/2008/Linear_Collider.html)
ILC Electron Source Gets Help from JLab (http://www.jlab.org/news/articles/2008/ElectronResources.html)

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