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# Cryogenic Research at ICSI Cryogenic Laboratory

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The ICSI Cryogenic Laboratory conducts both fundamental and applied research within national programs and international collaborations such as F4E, ITER, and FAIR, as well as for industrial applications.
1. Cryogenic Material Testing
To meet the need for determining material properties at cryogenic temperatures, a dedicated Cryogenic Mechanical Testing Facility has been established. A key innovation is a patented cryostat for tensile strength testing of materials at 77 K, developed in-house. This system attracted the interest of Zwick-Roell, who proposed collaboration to raise its TRL level for potential commercial integration with their testing systems. This process is currently ongoing.
2. Isotopic Hydrogen Separation
Due to the need for isotopic separation of hydrogen mixtures —including tritium —technologies essential for CANDU and fusion reactors (ITER), an experimental stand for high-purity protium and deuterium production by cryogenic distillation was developed. For optimal cooling of the column feed streams, a Matrix Heat Exchanger was designed, manufactured, and tested. A new method for conditioning chromatographic columns was also developed, enabling accurate analysis of ortho–para hydrogen, HD, and deuterium species.
3. Helium and Hydrogen Isotope Separation
Within a national research program, methods for $^{3}He$–$^{4}He$ and $^{4}He$–$H_2/D_2$ separation are under development and testing, expanding the laboratory's capabilities in isotopic purification.
4. Hydrogen Liquefaction and Storage
In connection with the upcoming Hydrogen Research and Applications Center at ICSI, two separate liquid hydrogen production systems are being designed and implemented:
• A Stirling-type liquefier, dedicated mainly to mobile storage applications.
• A Linde HRLS 11 helium liquefaction/refrigeration system, supplying liquid hydrogen to a stationary storage unit.
To ensure safe and efficient storage, studies have been conducted on maximizing ortho–para hydrogen conversion prior to liquefaction.

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