VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING TECHNOLOGY

of **Ben Cloostermans**

The public defense will take place on **Wednesday 18th November 2026 at 5pm** in room **D.0.08** (Building D, VUB Main Campus)

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FIBER-OPTIC SENSING FOR LEAKAGE DETECTION AND PREVENTION IN BOLTED FLANGE CONNECTIONS: BRIDGING LABORATORY RESEARCH AND INDUSTRIAL APPLICATION

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Abstract of the PhD research

How can we detect that an industrial pipe connection is at risk of leaking before a leak occurs? This question is particularly important in chemical and petrochemical plants, where thousands of pipe connections must remain leak-tight under demanding operating conditions. Even a small leak can lead to product loss, environmental pollution, safety hazards, and costly maintenance. Yet, detecting the early signs of a weakening seal remains a major challenge.

This dissertation investigates a novel monitoring approach based on embedding fiber-optic sensors within the pipeline gaskets. These gaskets are seals compressed between connected parts to prevent liquids or gases from escaping, and the optical fibers use light to measure how much the gasket is compressed and how this changes over time. As such, the sensors provide valuable information about the mechanical condition of the connection and potential changes that could compromise its sealing performance.

Laboratory tests established a link between the sensor readings and the gasket's ability to prevent leaks. Trials in an operating petrochemical refinery then showed that the sensors could reveal uneven compression during assembly and detect small changes in compression during operation.
Beyond demonstrating technical feasibility, this work also examines how the technology could be used in industry and brought to market. As industry increasingly adopts digital monitoring solutions to improve reliability, safety, and sustainability, fiber-optic instrumented gaskets could contribute to a shift from reactive maintenance toward proactive leak prevention, helping operators to act before leaks occur.

These smart gaskets could help operators check whether a gasket has been installed correctly and provide a warning before leaks occur, contributing to safer industrial operations and lower emissions.