（学校用）

様式 A-1
(FY2024)

2025年　3月　4日

サイエンス・ダイアログ　実施報告書

1. 学校名・実施責任者氏名: 仙台市立仙台青陵中等教育学校 ・ 西岡 慧

2. 講師氏名: Dr. Arnold Bingler

3. 講義補助者氏名:

4. 実施日時: 2025 年 2 月 26 日（水） 13 : 20 ～ 15 : 20

5. 参加生徒: 1 年生 131 人、 ___年生 ___人、 ___年生 ___人（合計 131 人）
備考: 普通科の生徒

6. 講義題目: Eddy-current non-destructive testing of carbon fiber-reinforced plastics

7. 講義概要:

Carbon fiber-reinforced plastic (CFRP) materials have an important role in nowadays' technology. Due to their light weight, great strength and durability, they are widely used in various fields, such as the automotive industry, aerospace industry or even in leisure activities, like making tennis rackets. The thin (7um diameter) carbon fibers are glued into a matrix resin, then the filaments can be interwoven or layers are stacked on top of each other, which results in a strong, but lightweight material. The mechanical properties of the CFRPs can significantly reduce in the presence of errors in the fiber structure (fiber waviness, fiber break, misorientiation) or in the presence of material defects, such as cracks or voids. Many non-destructive testing methods have been developed to detect these material defects, for example, X-ray scan and ultrasound testing. Since the carbon fibers have a non-negligible conductivity, eddy-current testing (ECT) methods can also be applied. During the ECT measurement a small, sensitive coil sensor is placed at a very close distance (lift-off) above the CFRP specimens. A sinusoidal voltage signal is applied to the coil that generates eddy-currents inside the specimen. Any small change in the fiber structure will modify the eddy-currents and these small changes can be detected by the coil. Hence, by moving (scanning) the coil over the CFRP specimen, we can get valuable information about the fiber structure and detect the material defects.

8. 講義形式:
☒対面 ・ □オンライン （どちらか選択ください。）

1) 講義時間 90 分　　質疑応答時間 10 分

2) 講義方法（例:プロジェクター使用による講義、実験・実習の有無など）
プロジェクター使用による講義、講師による実験の実演有り

3) 事前学習
(有) ・ 無 （どちらかに〇をしてください。）
使用教材 講師から送付された今回の講義の abstract とその他講義に関するオンラインページ

9. その他特筆すべき事項:

Form B-2
(FY2024)
Must be typed

Date（日付）
06/03/2025 （Date/Month/Year：日/月/年）

Activity Report -Science Dialogue Program-
（サイエンス・ダイアログ 実施報告書）

- Fellow's name（講師氏名）: Bingler Arnold （ID No. P23353）

- Name and title of the lecture assistant（講義補助者の職・氏名）
I did not have a lecture assistant.

- Participating school（学校名）: Sendai City Sendai Seiryo Secondary School

- Date （実施日時）: 26/02/2025. （Date/Month/Year:日/月/年）

- Lecture title（講義題目）:
Eddy-current non-destructive testing of carbon fiber-reinforced plastics

- Lecture format（講義形式）:
◆☒Onsite ・ ☐Online (Please choose one.)（対面 ・ オンライン）（(どちらか選択ください。)）
◆Lecture time（講義時間） 90 min（分）, Q&A time（質疑応答時間） 10 min（分）
◆Lecture style（ex.: used projector, conducted experiments）
（講義方法（例：プロジェクター使用による講義、実験・実習の有無など））
Projector + conducted experiments + sample specimens to be examined by students

- Lecture summary（講義概要）: Please summarize your lecture within 200-500 words.

Carbon fiber reinforced plastic (CFRP) materials are becoming widespread in various industrial fields such as aerospace industry and automotive industry. Their light weight, strength and durability makes them an ideal replacement for aluminium and steel. Due to their structure, their mechanical properties are sensitive to any material defects (fiber break, misalignment, voids, etc), hence non-destructive methods are being used to identify such defects inside the CFRP materials in order to estimate and evaluate their strength and expected lifetime.

My presentation focused on the eddy current nondestructive testing of CFRP materials. In the first part, I gave the students a brief summary about myself and my country, followed by an explanation about what being a researcher means. I explained them the various career paths involved in their university studies as well as the advantages and future possibilities that they can get if they stay in the university as a doctorate student and researcher.

In the next part, I explained the meaning of CFRP, its properties and usage in various industrial

fields. I also brought some CFRP specimens, so student can test their light weight and strength. Then, I explained the possible material defects in these materials and the importance of finding them via some non-destructuve testing methods. Finally, I started focusing on the special eddy current testing method.
Since students have limited background in physics, I had to build a common knowledge step-by-step. I explained the physical phenomenon of induction and eddy currents via some simple everyday examples such as induction cooking and antennas. I demonstrated the presence and effect of eddy currents with a simple experiment where a strong neodymium magnet dropped into a copper tube is falling very slowly to due the induced eddy currents and the resulted counter magnetic force.

Based on these examples, I explained them how we can use these eddy currents to detect certain material defects inside the CFRP, by detecting the change in the magnetic field caused by the presence of the defects. I showed them a very simple measurement (including videos) where a slit is present in a stainless steel material, since in this case the slit signal in a 1D and 2D scan is straightforward and easy to understand. Then, I showed them experiements and videos about ECT measurement of CFRP materials. I explained the difficulties and the connection between the 2D ECT scan and the fiber distribution of the CFRP and how we can use this connection to find various defects: CFRP with slits, multilayered CFRP with misaligned layers, measurement of CFRP used for hydrogene tanks. Finally, I showed them some advanced modeling and simulation methods that they may learn about later during their university studies. During the break, the students had to possibility the investigate the CFRP samples and other experimental tools that I brought. As much as I could, I put Japanese texts and explanations in the slides.

◆Other noteworthy information（その他特筆すべき事項）:

My personal expression was that the students were quite excited when I showed them the neodymium magnets and the eddy current experiments, and also enjoyed inspecting the CFRP samples. This reinforces, that it is very important to involve as much hand on experiment as we can if want to make science interesting for students. The questions that I got at the end of the presentation were very good, it clearly showed that they could more or less follow and understand the presentation.

- Impressions and comments from the lecture assistant（講義補助者の方から、本プログラムに対する意見・感想等がありましたら、お願いいたします。）: