



R/V *Yokosuka* Cruise Report

YK23-07C

Basic characteristic evaluation for laser direct joint
of difficult-to-adhesive composite materials to light metals
in the deep sea

Central Okinawa Trough

29th Apr. 2023 – 4th May 2023

Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

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1. Cruise Information

- Cruise ID: YK23-07C
- Name of vessel: R/V *Yokosuka*
- Title of cruise: Basic characteristic evaluation for laser direct joint of difficult-to-adhesive composite materials to light metals in the deep sea
- Chief Scientist [Affiliation]: Kazuya Kitada [JAMSTEC]
- Cruise period: 29th April 2023 to 4th May 2023
- Ports of departure and arrival: Naha to Yokosuka HQ
- Research area: Iheya-North Knoll, the southern flank of Iheya Minor Ridge and Izena Hole at the Central Okinawa Trough
- Research map:

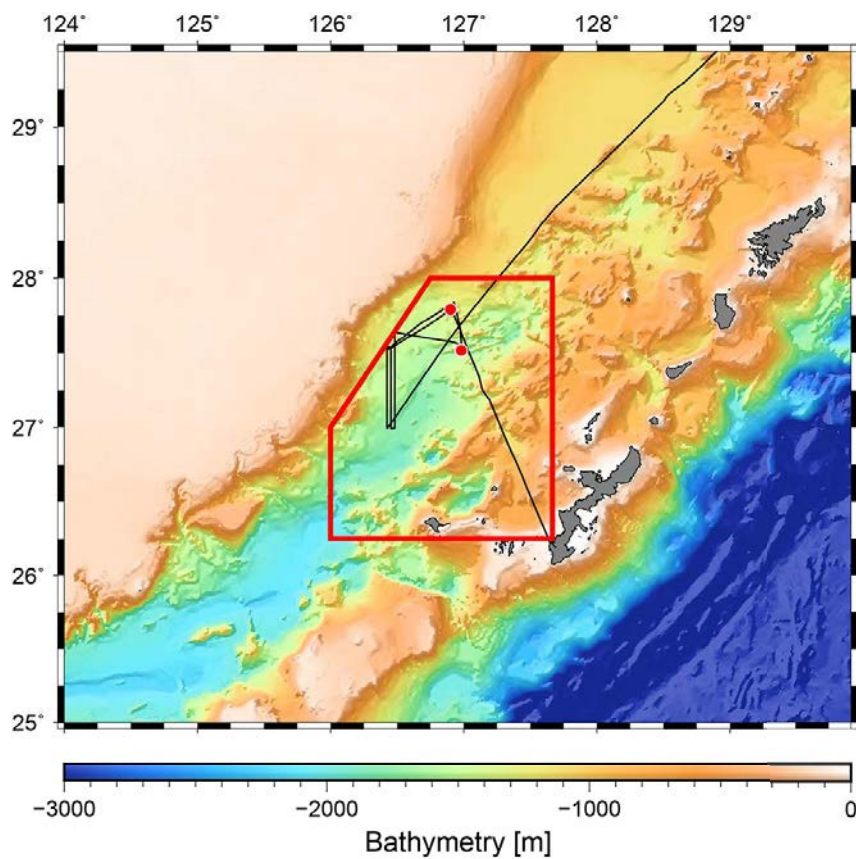


Fig. 1 Survey area and ship track during the YK23-07C cruise.

2. Research Proposal, Science Party and Crews

- **Title of proposal:**

Basic characteristic evaluation for laser direct joint of difficult-to-adhesive composite materials to light metals in the deep sea

- **Representative of the Science Party [Affiliation]**

Yosuke Kawahito [JAMSTEC]

- **Science Party (List) [Affiliation, assignment etc.]**

Kazuya Kitada [JAMSTEC]

Tatsumi Kawafuchi [Hirotec Corp.]

Shungo Imanishi [Hirotec Corp.]

- **R/V *Yokosuka* crew members:**

Captain	Takafumi Aoki
Chief Officer	Hiroyuki Kato
1st Officer	Tetsuo Shirayama
2nd Officer	Tatsumi Deguchi
3rd Officer	Riku Matsuda
Jr.1st Engineer	Shinichi Ikuta
1st Engineer	Takahiro Mori
2nd Engineer	Takamasa Ochiai
3rd Engineer	Kazunami Matsumoto
Jr.3rd Engineer	Koki Shimizu
Chief Electronic Op.	Masamoto Takahashi
2nd Electronic Op.	Ryuji Onikubo
Boatswain	Kaito Murata
Quarter Master	Kazumi Ogasawara
Quarter Master	Tsuyoshi Chimoto
Quarter Master	Hiroaki Nagai
Quarter Master	Shinya Kojima
Sailor	Ryo Nakanishi
Sailor	Taisei Matsuda
No.1 Oiler	Junji Mori
Oiler	Ryota Suzuki
Oiler	Toru Hidaka
Assistant Oiler	Yuta Wakugawa
Assistant Oiler	Eima Fujiura

Chief Steward	Kazuhiro Hirayama
Steward	Tsuyoshi Nagatomo
Steward	Koichiro Kashiwagi
Steward	Yuki Shirasaki
Steward	Tsugumi Tanaka

● **HOV *SHINKAI 6500* operating team:**

Submersible Operation Manager	Kazuhiro Chiba
Deputy Submersible Operation Manager	Keita Matsumoto
1st Submersible Staff	Mitsuhiro Ueki
1st Submersible Staff	Akihisa Ishikawa
2nd Submersible Staff	Hirofumi Ueki
2nd Submersible Staff	Keigo Suzuki
2nd Submersible Staff	Takuma Onishi
2nd Submersible Staff	Satsuki Iijima
2nd Submersible Staff	Naoto Minamino
3rd Submersible Staff	Motohiro Matsusaka
3rd Submersible Staff	Daiki Ichinose
3rd Submersible Staff	Kaisei Sato
3rd Submersible Staff	Haruna Sasaki

● **Marine Technician:**

Chief Observation Engineer	Hisanori Iwamoto
Observation Engineer	Wataru Tokunaga
Observation Engineer	Mitsuteru Kuno

3. Observations

3.1 Objectives & Background

PEEK-CFRP is expected to be suitable for drone taxis, space elevators, next-generation aircraft, and deep-sea submarines. This research has the potential to contribute to their applications significantly. However, bonding PEEK-CFRP to metal using conventional adhesives proves challenging due to its chemical structure. Therefore, a new dissimilar material joining technology for PEEK-CFRP and metal is necessary to overcome this adhesion difficulty. Specifically, the metal is assumed to be aluminum alloy, titanium alloy, or magnesium alloy. Laser direct joining, developed by Kawahito et al. in 2008, has garnered attention as one of the potential solutions.

This project elucidates the direct joining mechanism between difficult-to-adhere composites and light metals with a laser through state-of-the-art observation, laboratory analysis, and numerical analysis. Moreover, we achieve joint strength and reliability that can be utilized in space and the deep sea by deriving the dominant joining factors from the peeling process occurring at the joint interface and controlling these factors.

3.2 Dive Information & Preliminary Results

During this cruise, we performed two HOV *SHINKAI 6500* dives in the hydrothermal areas of the Iheya North Knoll and the Iheya Minor Ridge in the Central Okinawa Trough. To evaluate the laser direct joining of difficult-to-adhesive composite materials to light metals in the deep sea, we installed four sets of laser direct joining sample evaluation equipment. Three sets were placed at the Iheya North Knoll, and the other one set was placed at the Iheya Minor Ridge. The equipment was installed on the platform above drilled holes and on the seafloor about 100 meters away from the hole. All the installed equipment is planned to be recovered during the second cruise in FY2023 and cruises in FY2024. We also conducted in-situ sensor measurements such as temperature, pressure, turbidity and magnetic field, and rock sampling in the vicinity of the evaluation test sites. In addition, regional geophysical surveys (bathymetry, hydrothermal plume survey and magnetic field) were conducted by the R/V *Yokosuka*.

3.2.1 HOV *SHINKAI 6500* Dive 1682 (30th April 2023) at the southern flank of Iheya Minor Ridge

Payload:

Laser direct joining sample evaluation equipment x 1, Total field magnetometer x 1,
Three-component magnetometer x 1, Thermometer for hydrothermal fluid x 1, Turbidity meter x 1,
Sample box x 1

Operation:

After landing on the seafloor, the *SHINKAI 6500* moved to the artificial hydrothermal vent of Site-2 to observe the condition of the platform. One set of laser direct joining sample evaluation equipment (ID: YK23-07C #1) was installed at Site-2 ($T_{\max} = 75.7\text{ }^{\circ}\text{C}$). After the installation, the *SHINKAI 6500* moved to the Hole C9017A and observed the hydrothermal chimney and the condition of the platform. Finally, the *SHINKAI 6500* moved to observe the seafloor around the sites and collected three rock samples by

manipulator.

3.2.2 HOV *SHINKAI 6500* Dive 1683 (1st May 2023) at the Original Site, Iheya-North Knoll

Payload:

Laser direct joining sample evaluation equipment x 3, Total field magnetometer x 1,
Three-component magnetometer x 1, Thermometer for hydrothermal fluid x 1, Turbidity meter x 1,
Sample box x 1

Operation:

After landing on the seafloor, the *SHINKAI 6500* moved to the artificial hydrothermal vent of Site-1 to observe the condition of the platform. Two sets of laser direct joining sample evaluation equipment (IDs: YK23-07C #2 and YK23-07C #3) were installed on the platform of Site-1 ($T_{\max} = 309.7\text{ }^{\circ}\text{C}$). The *SHINKAI 6500* moved to the 110 meters north of Site-1 and one set of laser direct joining sample evaluation equipment (ID: YK23-07C #1) was installed on the seafloor. After the installation, the *SHINKAI 6500* observed the seafloor around the installed sites and moved to the Hole C0014G. The temperature measurement of the hydrothermal fluid was conducted at the site ($T_{\max} = 76.2\text{ }^{\circ}\text{C}$). After the measurement, the *SHINKAI 6500* moved to observe the seafloor in the western part of the survey area and collected four rock samples by manipulator.

4. Cruise Log

29 Apr.,2023	10:00	Scientists onboarded
	15:30-16:00	<i>SHINKAI 6500</i> team and Scientists team meeting
	16:00	Left Naha for research area
	16:00-16:40	<i>SHINKAI 6500</i> briefing
30 Apr.,2023	06:00	Arrived at research area
		Due to strong current, changed the research area
	08:31-09:02	Surface geophysical survey
	11:59	<i>SHINKAI 6500</i> dove, and started her operation dive No.1682
	12:51	<i>SHINKAI 6500</i> landed on the sea bottom
	16:24	<i>SHINKAI 6500</i> left the sea bottom
	17:27	Recovered <i>SHINKAI 6500</i>
	20:20-	Surface geophysical survey
01 May,2023	-03:30	Surface geophysical survey
	09:12	<i>SHINKAI 6500</i> dove, and started her operation dive No.1683
	09:49	<i>SHINKAI 6500</i> landed on the sea bottom
	14:34	<i>SHINKAI 6500</i> left the sea bottom
	15:27	Recovered <i>SHINKAI 6500</i>
	18:28-18:48	Eight figure turns

	18:54-22:06	Surface geophysical survey
	22:10	Left research area
02 May,2023		Transit to Yokosuka HQ, JAMSTEC
03 May,2023		Transit to Yokosuka HQ, JAMSTEC
04 May,2023	11:00	Arrived at Yokosuka HQ, JAMSTEC

5. Notice on Using

This cruise report is a preliminary documentation as of the end of cruise.

This report is not necessarily corrected even if there is any inaccurate description (i.e. taxonomic classifications). This report is subject to be revised without notice. Some data on this report may be raw or unprocessed. If you are going to use or refer the data on this report, it is recommended to ask the Chief Scientist for latest status.

Users of information on this report are requested to submit Publication Report to JAMSTEC.

<http://www.godac.jamstec.go.jp/darwin/explain/1/e#report>

E-mail: submit-rv-cruise@jamstec.go.jp