

Application News

High-Speed Video Camera

High-Speed Imaging of Arc Behavior in Lightning Strike Tests

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User Benefits

- ◆ The HPV™-X3 records at up to 20 Mfps, enabling the observation of ultra-fast phenomena.
- ◆ Compared with the previous model, the HPV-X3 provides three times the resolution, enabling clearer observation of lightning current propagation.

Introduction

Aircraft materials can suffer localized thermal and mechanical damage when struck by lightning during flight. Because such damage can reduce operational efficiency, lightning damage mitigation is required. Understanding the underlying damage mechanisms is therefore critical.

One method used to simulate actual lightning phenomena is the arc-entry test. In an arc-entry test, a simulated lightning current is delivered to the specimen through a fine aluminum wire attached to an insulating sphere at the electrode tip.¹⁾ Because a lightning strike proceeds from initiation to extinction in an extremely short time, high-speed recording is required to capture the process.

In this paper, high-speed imaging of the lightning tests was performed using the HPV-X3 (Fig. 1), allowing observation of the simulated lightning current's propagation from an aluminum wire to the specimen.



Fig. 1 HyperVision™ HPV-X3 High-Speed Video Camera

Imaging System

Fig. 2 shows the imaging setup. The imaging was performed using self-emission from the lightning strike at a recording speed of 20 Mfps. The imaging target is shown in Fig. 3. An insulating sphere was attached to the electrode tip. A Φ 0.2 mm aluminum wire was then attached to the electrode and allowed to hang along the surface of the sphere.

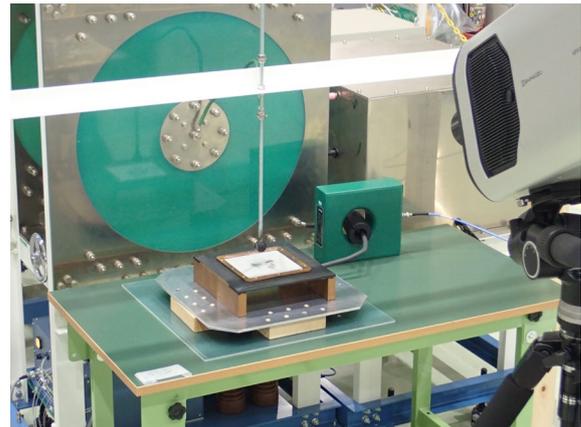


Fig. 2 Imaging Setup

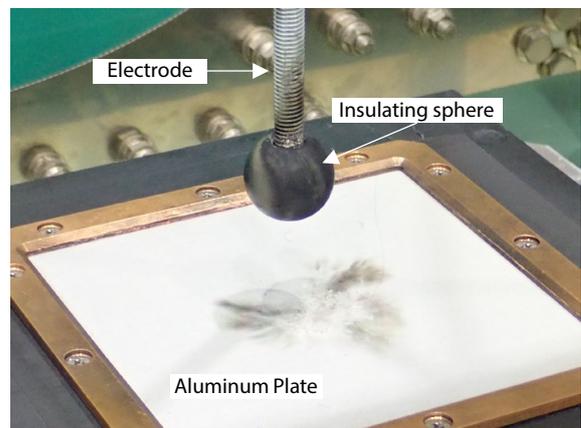


Fig. 3 Imaging Target

■ Imaging Results

Fig. 4 shows images from the lightning tests. In frame (1), a faint discharge is observed between the tip of the aluminum wire and the aluminum plate. By frame (3), 0.4 μ s later, light along the wire is visible. The emitted light becomes stronger through frames (4) and (5), then expands like smoke in frames (6) to (8). After recording, the aluminum wire was no longer present; it is therefore inferred that the wire was vaporized into plasma by the strike.

■ Conclusion

Using the HPV-X3 high-speed video camera, the behavior of a fine aluminum wire during lightning tests was recorded, and the propagation sequence of the simulated lightning current was observed. The interval between the onset of discharge and the formation of plasma on the aluminum wire was approximately 0.4 μ s, demonstrating the ultrafast nature of the phenomenon. The HPV-X3 records at up to 20 Mfps, making it well suited for observing such phenomena.

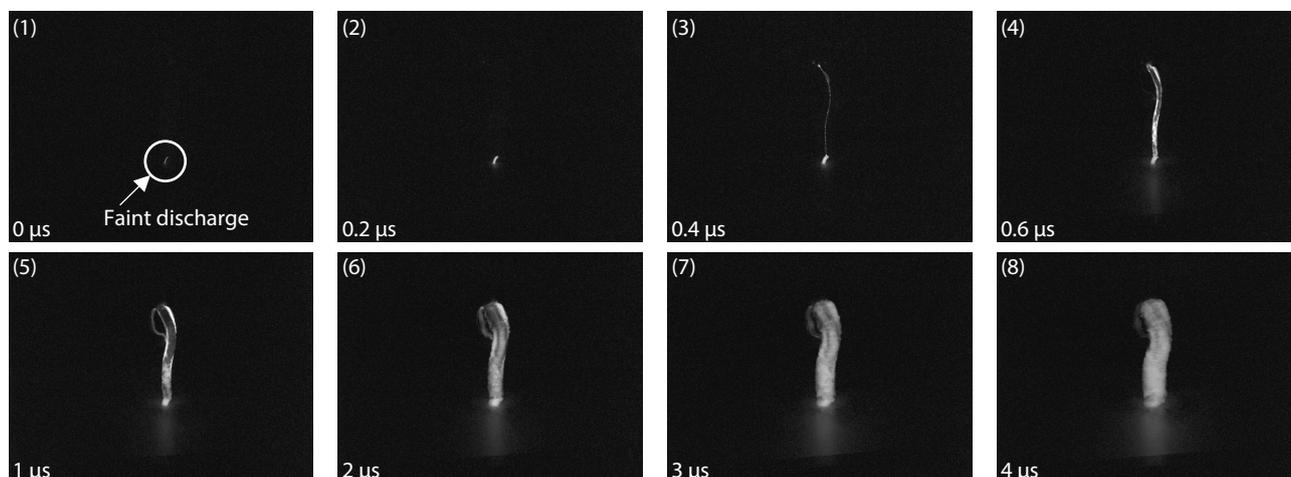


Fig. 4 Images from the Lightning Tests (Recording Speed: 20 Mfps)

Imaging cooperation:

Aviation Technology Directorate, Japan Aerospace Exploration Agency

References

- 1) S. Kamiyama, T. Okada, H. Miyaki, Y. Hirano and T. Ogasawara: Effect of Inter-laminar Toughened Layer on Lightning Strike Damage to CF/epoxy Composites, *Journal of the Japan Society for Composite Materials*, 50, 2, pp. 70-76, (2024).

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01-01164-EN

First Edition: Mar. 2026

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