Identification of wooden keris sheath using synchrotron X-ray microtomography

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Introduction

Keris

UNESCO recognised Keris as an intagible heritage from Indonesia. For keris sheath, usually using wood as the main material.

Limited information about the wood selection, especially about wood anatomical features.

Wood identification

Wood identification is usually conducted by preparing thin section observed under optical microscope

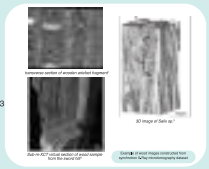
Disadvantages

time consuming | need experience & skill | need much samples | destructive

Not applicable for cultural wood

Synchrotron X-Ray microtomograpy for identifying cultural wood

- Identification of wood taxa selected for archaeological artefact manufacture in Australia[1]
- Identification of wooden artefact from excavated grave[2]
- Identification of Korean wooden mask[3]

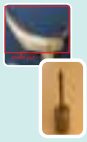


[1]Whitau et al. Journal of Archaeological Science: Reports 6 (2016) 536–546
[2]Stabrner & Miller. Journal of Archaeological Science 55 (2015) 198–196
[3]Mizuno et al.Journal of Archaeological Science 37 (2010) 2842–2845

Aim

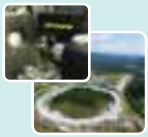
Identify the species that is used as material of wooden keris sheath from Indonesia

Materials and Method

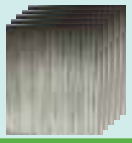


Five sheaths sample, namely, WR-001, WR-002, WR-003, WR-004, and WR-005

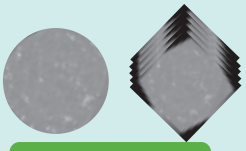
Small wood fragment with 0.7 mm in diameter and 5 mm in length was cut from each sheath sample.



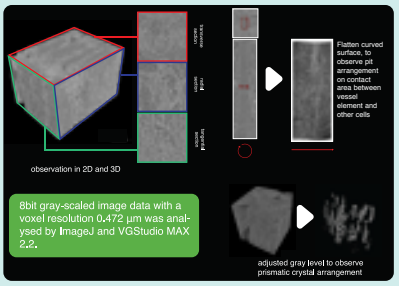
The experiment was conducted using medical imaging beamline BL20XU at SPring-8



As many as 1800 transmission images were recorded using a high-resolution camera (2048 x 2048 pixel)



3D image data was reconstructed by CUDA accelerated algorithm of filtered back projection.



Results and Discussion

Two-dimensional (2D) and Three-dimensional (3D) image of samples

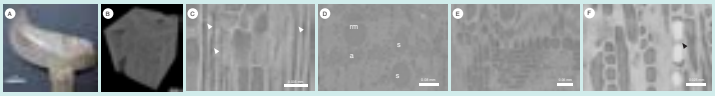


Figure 1. Observation of sample WR-001: photograph of sample **(A)**, 3D rendering **(B)**, septate fiber (arrowhead) **(C)**, transverse section shows axial parenchyma band (a) and vessel grouping of solitare (s) and radial multiple (rm) **(D)**, radial section shows heterogenous ray cells **(E)**, prysmatic crystal (arrowhead) in axial parenchyma **(F).**

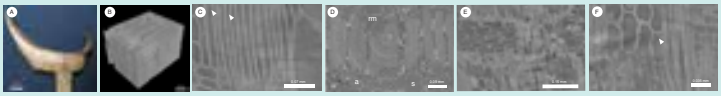


Figure 2. Observation of sample WR-002: photograph of sample **(A)**, 3D rendering **(B)**, septate fiber (arrowhead) **(C)**, transverse section shows axial parenchyma band (a) and vessel grouping of solitare (s) and radial multiple (rm) **(D)**, radial section shows homogenous ray cells **(E)**, deposit (arrowhead) in axial parenchyma **(F).**

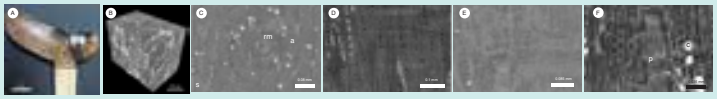


Figure 3. Observation of sample WR-003: photograph of sample **(A)**, 3D rendering **(B)**, transverse section shows axial parenchyma band (a) and vessel grouping of solitare (s) and radial multiple (rm) **(C)**, tangential section shows uniseriate ray **(D)**, radial section shows heterogenous ray cells **(E),** prysmatic crystal in axial parenchyma (c) and simple perforation plate (p) **(F).**

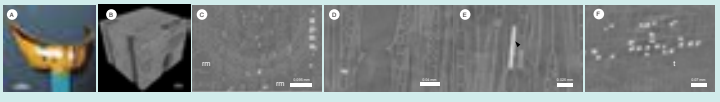


Figure 4. Observation of sample WR-004: photograph of sample **(A)**, 3D rendering **(B)**, transverse section shows vessel grouping of radial multiple (rm) **(C)**, tangential section shows simple perforation plate **(D)**, needle-shaped crystal (arrowhead) **(E),** radial section shows tile cells (t) and prysmatic cristal in ray parenchyma (c) **(F).**

Figure 5. Observation of sample WR-005: photograph of sample **(A)**, 3D rendering **(B)**, transverse section shows vessel grouping of solitaire (s) **(C)**, deposit in axial parenchyma (arrowhead) **(D)**, septate fiber (arrowhead) **(E),** radial section shows heterogeneous ray cells **(F).**

Flatten vessel element surface

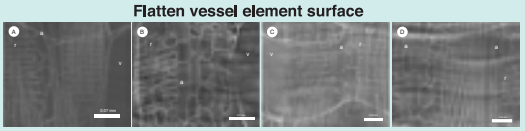


Figure 6. Flatten vessel element surface: sample WR-001 **(A)**, sample WR-002 **(B)**, sample WR-004 **(C)**, sample WR-005 **(D).** r: vessel-ray pit, a: vessel-axial parenchyma pit, v: intervessel pit

Prysmatic crystal arrangement

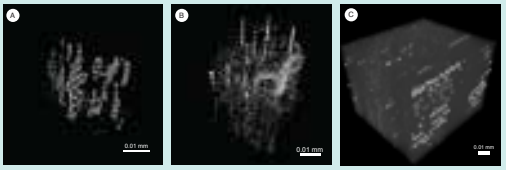


Figure 7. Prysmatic crystal arrangement: sample WR-001 **(A)**, sample WR-003 **(B)**, sample WR-004 **(C).**

Table 1. Summary of samples anatomical features

Anatomical features	WR-001	WR-002	WR-003	WR-004	WR-005
Vessel grouping	solitaire, radial multiple 2	solitaire, radial multiple 2	solitaire, radial multiple 3	radial multiple 2-3	solitaire
Vessel length	420-470 µm	270-340 µm	140-280 µm	240-350 µm	330-390 µm
Diameter of vessel lumen	70-80 µm	80-90 µm	60-80 µm	80-90 µm	90-100 µm
Perporation plate	simple	simple	simple	simple	simple
Intervessel pit	alternate, crowded	alternate, crowded	-	alternate, less crowded	-
Vessel-ray pit	horizontal grouping, less crowded	horizontal grouping, less crowded	-	horizontal grouping, less crowded	horizontal grouping, less crowded
Vessel-axial parenchyma	longitudinal series, crowded	longitudinal series, crowded	-	longitudinal series, less crowded	longitudinal series, crowded
Septate fiber	present	present	-	-	present
Ray cellular composition	heterogeneous	heterogeneous	heterogeneous	heterogenous	heterogeneous
Ray width	1-2 seriate	1-3 seriate	1-3 seriate	1-3 seriate	1-3 seriate
Crystal	axial parenchyma	-	axial parenchyma	ray parenchyma	-
Axial parenchyma type	aliform, band	band more than 3 cells wide	confluent	diffuse in aggregate	narrow band (up to 3 cells wide)
Tile cells	-	-	-	present	-

Identification Result

WR-001
This transverse section of this sample almost identic with WR-002, the main differences are abundance of prysmatic crystal on WR-001 (Fig. 7A), and different pattern of contact area on observed vessel element (Fig. 6A and 6B)

WR-002
This sample has solitaire and radial multiple vessel (Fig. 2D), axial parenchyma band more than 3 cells wide (Fig. 2D), and septate fibers (Fig. 2C) which is probably ***Dysoxylum sp.***

WR-003
This sample has axial parenchyma confluent (Fig. 3C), heterogeneous ray cells (Fig. 3E), three cells per parenchyma strand (Fig. 3E) which is probably ***Mangifera sp.***

WR-004
This sample has axial parenchyma diffus-in-aggregate (Fig. 4C), prismatic crystal in ray parenchyma cells (Fig. 4F) and tile cells (Fig. 4F)which is similar to ***Kleinhovia hospita***

WR-005
This sample has solitaire vessel (Fig. 5C), axial parenchyma narrow (up to 3 cells wide) band (Fig. 5C), and abundant septate fibers (Fig. 5E) which is probably ***Dysoxylum sp.***

Acknowledgement

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