

From Bark to Brushwork: Xuan Paper Craft & Ink Compatibility

Xuan Paper Physics Handbook

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1. What raw materials are used for Xuan Paper?

Xuan Paper is mainly made of **blue sandalwood bark** and rice straw. The bark forms the tough framework, while rice straw fills gaps to build a stable fiber network. During pulping, physical and chemical treatments break down lignin, separate fibers and enlarge their surface area for better bonding.

2. How has Xuan Paper craft evolved through history?

- Tang Dynasty (Origin): Pulped by water hammers. Fibers were poorly separated; paper was rough for basic writing.
- Song & Yuan Dynasties (Maturity): Fixed the ratio of bark and straw. Improved fiber structure boosted tensile strength and ink absorption.
- Ming & Qing Dynasties (Peak): Mature sun-bleaching technique retained fiber strength and flexibility, creating top-grade ink-friendly Xuan Paper.
- Modern Times: Adopted electric machines and high-temperature drying for higher efficiency, yet brought new physical defects.

3. Traditional beating vs. modern mechanical beating

- Traditional water hammer: 40–60 impacts per minute. Fibers are separated gently, keeping long length and full toughness.
- Modern grinders: Over 1400 revolutions per minute. Strong friction cuts fibers easily, lowering paper durability and flexibility.

4. Physical principles of sheet forming

Fibers mix with water to make pulp suspension.

Dehydration follows Darcy's Law: water drains through mesh while fibers stack up.

- Hand-made paper: Unstable water flow causes fiber flocculation and natural cloud patterns.
- Machine-made paper: Precise flow control produces even texture with few flaws.

5. How drying shapes paper properties

Drying relies on capillary force and hydrogen bonding, the key to final paper quality.

As water evaporates, capillary force pulls fibers close. When the distance between fiber hydroxyl groups is less than 0.3 nm, tight hydrogen bonds form and strengthen the paper.

- Traditional slow drying: Fibers reorganize fully, forming soft yet sturdy texture.
- High-temperature cylinder drying (120°C–150°C): Surface hardens fast, leaving internal stress and making paper brittle.

6. Physical drawbacks of industrial production

1. Fiber damage: Shortened fibers reduce tensile strength and folding resistance.
2. Poor ink absorption: Insufficient hydrogen bonding makes ink stay on the surface.
3. Static electricity: High-speed operation generates static, leading to weak adhesion and edge warping.

7. How thickness & density affect writing feel

Xuan Paper is viscoelastic material.

- Thick paper: High bending stiffness, firm support for powerful strokes.
- Thin paper: Obvious elastic deformation creates a cushion effect. It may cause faint strokes for beginners, while skilled users control ink diffusion with this feature.

8. What causes rough or smooth paper surface?

Determined by surface roughness, porosity and friction coefficient.

- Raw Xuan Paper (low density): Loose fibers and large pores. Bristles lock into gaps, creating high friction and a rough feel.





- Sized Xuan Paper (high density): Glue and alum fill pores. Flat surface brings low friction and smooth touch.

9. The physics of ink diffusion on Xuan Paper

Ink is colloidal liquid. Capillary action pulls ink into fiber gaps: clear outlines form first, then water carries carbon particles to spread gradually, creating rich ink shades. This is the core of Xuan Paper's unique charm.

10. Mechanics of resistance and cushioning while writing

Writing is a friction-vibration system with three types of damping:

1. Air resistance to moving bristles
2. Viscous friction inside ink
3. Adsorption resistance from paper

Strong adsorption of raw Xuan Paper absorbs ink quickly, forming the unique rhythm of calligraphy.

11. How to match brushes with Xuan Paper

Brushes follow Hooke's Law with different elasticity.

Hard bristle brushes (weasel hair): Fast rebound. Pair with sized Xuan Paper for neat strokes and fine paintings.



Soft bristle brushes (goat hair): Large ink capacity and slow rebound. Pair with raw Xuan Paper for natural ink spreading and layered effects.

12. Why different inks perform differently

Mainly related to ink viscosity.

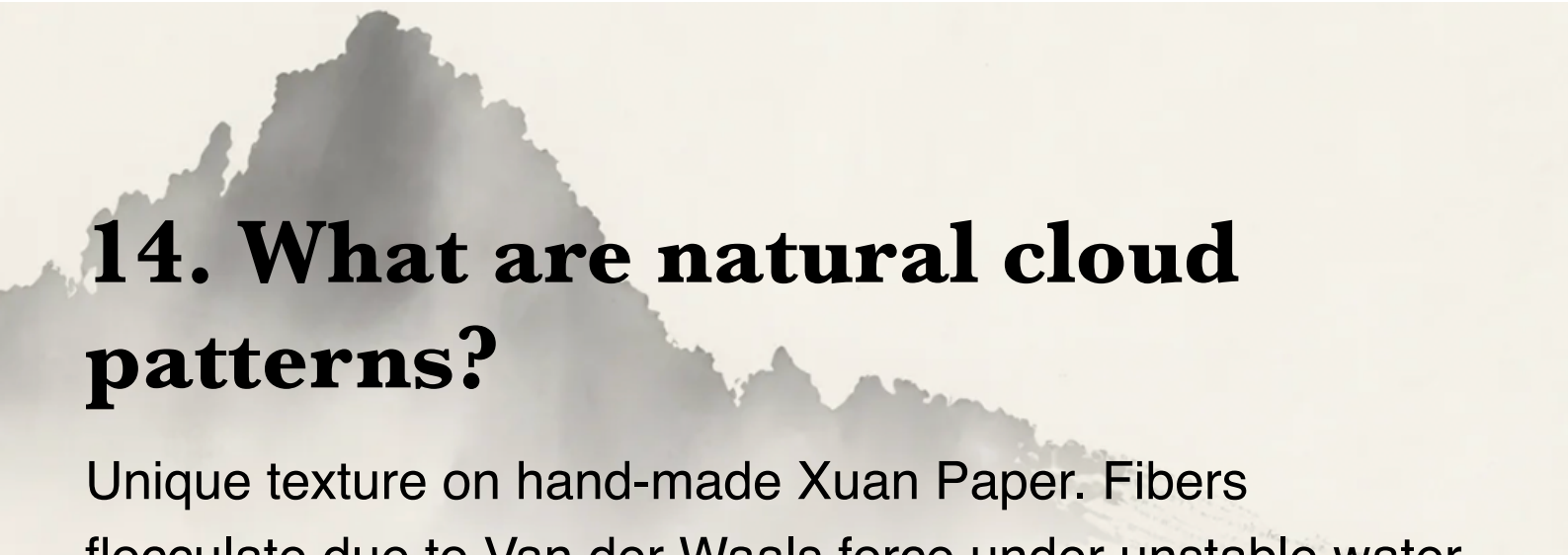
- Traditional pine soot ink: Moderate glue and high viscosity. It keeps clear outlines and spreads slowly for rich tones.
- Ordinary low-viscosity ink: Lacks binding force, spreads too fast and blurs strokes on raw Xuan Paper.

13. Rules for ideal brush, ink and paper combination

Dynamic balance formula:

Brush elastic force + Ink viscous force $\approx$ Paper adsorption force + Paper friction

- Good match: Long soft brush + aged traditional ink + premium raw Xuan Paper for smooth writing and perfect ink performance.
- Bad match: Hard brush on soft paper $\rightarrow$ brush slips and cannot hold ink; Soft brush on rough paper $\rightarrow$ excessive resistance twists bristles.



14. What are natural cloud patterns?

Unique texture on hand-made Xuan Paper. Fibers flocculate due to Van der Waals force under unstable water flow, forming uneven layers and artistic grain.

15. Why ancient Xuan Paper lasts for centuries

Traditional crafts protect complete long fibers and full hydrogen bonds. The stable fiber network maintains toughness and structure for a thousand years without becoming brittle.

16. Differences between raw and sized Xuan Paper

- Raw Xuan Paper: Loose structure, large pores, strong ink absorption and rough feel. Ideal for calligraphy and freehand painting.
- Sized Xuan Paper: Dense structure with sealed pores, low ink absorption and smooth surface. Suitable for detailed painting and small regular script.