



## Brief note

# Traditional Nanotechnology of Nepal

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**Abstract:** Some of the local traditional technologies of Nepal, despite lacking modern scientific terminologies in their common uses, have been found to possess inherent nanoscopic structural features. This article attempts to present some typical examples from Nepalese traditional practices, including Ayurvedic *Bhasma*, handmade paper, metallic and mineral particles-containing dyes and artifacts, and traditional cosmetics such as *Gajal*. Further, the historic expansion of the *Paubha* way of painting into Tibet, possibly through Princess *Bhrikuti*, underscores the cultural transmission of such nano-enabled art. These indigenous technologies demonstrate eco-friendly, sustainable, and culturally integrated approaches to materials science. The article emphasizes the value of exploring such practices to inspire contemporary emerging green nanotechnological innovations.

**Keywords:** Traditional technology; Ayurvedic Bhasma; Nepali paper; *Paubha* art, Metal plating; *Gajal*

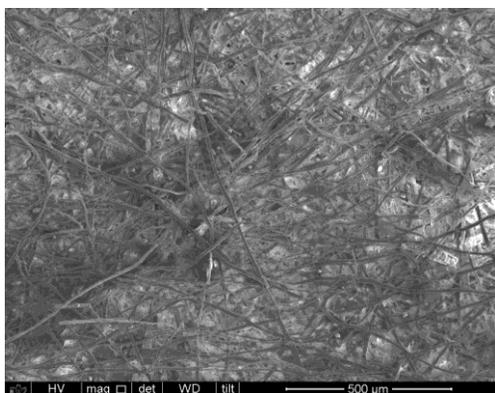
**शोधसार:** आधुनिक वैज्ञानिक पदावलीहरूको प्रयोग नभएतापनि नेपालका कैयौं परम्परागत प्रविधिहरू आफैंमा नानोविज्ञानका विशेषताहरूले सुशोभित रहेका छन्। प्रस्तुत छोटो आलेखमा नानोविज्ञानसंग संबन्धित गुणहरू ग्रहण गरेका आयुर्वेदिय भस्म, हस्तनिर्मित कागज, धातु एवं खनिज-जन्य कणिकाहरू समेतबाट संश्लेषित प्राकृतिक रङहरू, धातुलेपन संबन्धित कलाकृतिहरू, गाजलजस्ता परम्परागत सौन्दर्य प्रसाधनका बस्तु तथा पौभा: चित्रकला लगायतका परम्परागत अभ्यासहरूलाई प्रस्तुत गरिएको छ। सातौं शताब्दीमा राजकुमारी भृकुटी मार्फत तिब्बतमा पौभा: र थाङ्का कलाको प्रसारले समेत हाम्रो नानोविज्ञान-सम्बद्ध कलाको सांस्कृतिक पक्षलाई दर्शाउँछ। यस्ता रैथाने प्रविधिहरूले वातावरणमैत्री, दिगो र सांस्कृतिक रूपमा जोडिएको पदार्थ विज्ञानको दृष्टिकोण प्रस्तुत गर्दछन्। यो लेखमा यस्ता परम्परागत अभ्यासहरूको गहन अध्ययन-अनुसन्धान गरेर हरित नानोप्रविधिमा समेत नवीन प्रेरणा लिन सकिने विषयमा जोड दिने प्रयाश गरिएको छ।

Nanotechnology, the manipulation of matter at dimensions below 100 nm, has revolutionized materials science (Bhushan, 2017; Cademartiri and Ozin, 2009). However, many traditional technologies have unknowingly harnessed nanoscale phenomena long before the term "nanotechnology" was coined. Nepal, with its long-standing traditions in Ayurveda, Sowa-Rigpa medicine, metalwork, dyeing, and papermaking, provides fertile ground for investigating such practices. These indigenous methods, shaped by cultural, ecological, and philosophical principles, offer insight into sustainable, low-energy, and eco-friendly approaches to manipulating materials at or near the nanoscale.

**Ayurvedic Bhasmas:** One prominent example of traditional nano-formulation is the preparation of *Ayurvedic Bhasmas* and *Sowa-Rigpa Rasayanas*. Such traditional medicines, produced through repeated cycles of calcination and purification, are known to contain metal and mineral nanoparticles (Adhikari, 2014). Recent scientific investigations using electron microscopy have revealed that the *Bhasmas* often consist of particles in the nanometer range (Adhikari, 2014; Paudel et al., 2022). Gold-based *Swarna Bhasma* has been reported to have particles ranging between 20 and 60 nanometers, while copper Bhasma contains nanoparticles in the 50 to 100 nm range, potentially contributing to their

high surface reactivity and therapeutic bioavailability (Adhikari, 2014; Chaudhary, 2011).

**Handmade Paper:** In the field of traditional materials, handmade *Lokta* paper represents another compelling example. Made from the inner bark of *Daphne bholua* and *Daphne papyracea*, the paper exhibits a fibrillar and layered network structure when viewed under a field emission scanning electron microscope (FESEM) (see Fig. 1). The micro- and nano-structured cellulose matrix (Aryal et al., 2022; Thapa et al., 2025), combined with residual plant-based compounds, contributes to its antimicrobial and insect-resistant properties. Such features are analogous to those found in modern nanostructured antimicrobial packaging materials.



**Figure 1:** FESEM image of handmade traditional Nepali paper (Adhikari, R. et al, unpublished result)

**Natural Dyes:** Natural dyes, extensively used in Nepali textiles, also show evidence of nanoscale behavior. Extracts from plants like turmeric, indigo, walnut, and madder, when used with mordants such as alum or iron salts, form stable pigment nanoparticles in aqueous suspensions. These nanopigments demonstrate enhanced binding properties and improved resistance to photodegradation, contributing to the longevity and vibrancy of traditional textiles (Bhandari et al., 2021). The controlled aggregation of pigment molecules and their interaction with fabrics highlight parallels with colloidal and supramolecular chemistry in modern dye technologies.

**Metal Plating:** Equally significant is the traditional metal craftsmanship, particularly among Newa artisans of the Kathmandu valley (Joshi et al, 2022; Furger, 2017). Their use of natural abrasives and polishing techniques produces oxide layers and surface finishes at nanometer-scale thickness. Ancient statues and ritual objects made from gilded

copper alloys have been shown to possess nanoscale corrosion-resistant coatings, an unintended yet effective surface engineering strategy. Surface analysis studies confirm that these nano-layers contribute to the longevity and aesthetic appeal of these historical artifacts (Furger, 2017).

**Gajal:** Another notable example of traditional nanotechnology deeply rooted in Nepal is the preparation and use of *Gajal*, a black eye cosmetic widely used for both aesthetic and medicinal purposes. Traditionally, *Gajal* is made by collecting fine soot particles produced from the incomplete combustion of natural oils (such as castor oil or ghee), which are then mixed with herbal oils or ghee to form a smooth paste. Scientific studies suggest that these soot particles are often in the nanometer size range, imparting unique surface properties such as enhanced adhesion, antimicrobial activity, and stability (Sohail et al., 2018; Randhiv et al., 2020). The nanoscale structure contributes not only to the cosmetic appeal of *Gajal* but also to its therapeutic effects, protecting and lubricating the eyes, illustrating the intersection of indigenous knowledge with nanoscience principles.

**Paubha Painting:** A particularly rich and symbolic example of traditional nano-enabled art is the *Paubha* painting tradition, exemplified by the *Prajnaparamita Paubha* preserved at *Hiranyavarna Mahavihara* in Patan (See Fig. 2). Such intricate artworks are painted using finely ground mineral or metals (such as gold and silver) and plant pigments, many of which display the particle diameter well below the micron scale.



**Figure 2:** Photograph showing the repair of the *Prajnaparamita Paubha* at Hiranyavarna Mahavihara, Patan (<https://risingnepaldaily.com/news/30187>)

Artists traditionally mix the pigments with natural binders, often in oil or water-based vehicles,

allowing for uniform dispersion and fine detailing at an extremely small scale (Gurung, 2025). The nanoparticle, which might form, hence contributes to both aesthetic beauty and long-term preservation. These paintings also exhibit excellent adhesion and resistance to fading, likely due to the stabilization of nano-pigments within natural organic matrices.

There is evidence of the expansion of *Paubha* and *Thangka* art in Tibet, linked historically to Princess Bhrikuti of Nepal, who, according to traditional accounts, married the Tibetan King Songtsen Gampo in the 7<sup>th</sup> century (Shakya, 2013). As a devout Buddhist and patron of the arts, Bhrikuti is believed to have introduced Nepali artisans and religious iconography to Tibet, thus fostering the development of Thangka painting, a close derivative of *Paubha* art.

**Conclusion:** Some notable traditional technologies of Nepal illustrate how indigenous knowledge systems can be linked in inspiring ways with the essence of modern nanoscience. By examining these practices through a scientific lens, we uncover nanoscale principles rooted in centuries-old wisdom. These insights not only enhance our understanding of historical technologies but also pave the way for developing sustainable nanomaterials and processes.

Future interdisciplinary research endeavors bridging traditional knowledge and cutting-edge science could yield transformative benefits in environmental remediation and sustainable materials development.

**Acknowledgment:** The author sincerely dedicates this work, with heartfelt gratitude, to the late Professor Chhabi Lal Gajurel, in honor of his unparalleled and ever-inspiring contributions to the traditional technologies, arts, and crafts of Nepal.

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