Bioactive Polyphenol-Gallium Nanocoatings for Nitric Oxide Release and Enhanced Biomedical Implant Performance

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We introduce a novel bioactive nanocoating system that integrates natural polyphenols and liquid gallium(Ga) particles, offering potential applications in biomedical stents. This coating is formed through the coordination of tannic acid (TA) with zirconium (Zr^{4+}) ions, creating a robust and adhesive matrix suitable for diverse surfaces, including metallic and polymeric substrates. The embedded gallium particles serve as a dynamic reservoir for nitric oxide (NO) generation, a key molecule in vascular function. By facilitating NO release, these coatings support endothelial proliferation and may help mitigate restenosis. The deposition process is rapid, and both the coating thickness (ranging from 100 to 700 nm) and gallium content can be precisely tuned to control NO release kinetics. In addition to their NO-releasing properties, these coatings have the potential to exhibit antioxidant, antimicrobial, and anti-inflammatory effects, making them highly promising for biomedical applications. By combining the benefits of NO with the strong adhesion and stability of zirconium-polyphenol networks, this approach offers a versatile strategy for next-generation stent coatings aimed at improving vascular healing and long-term implant performance.

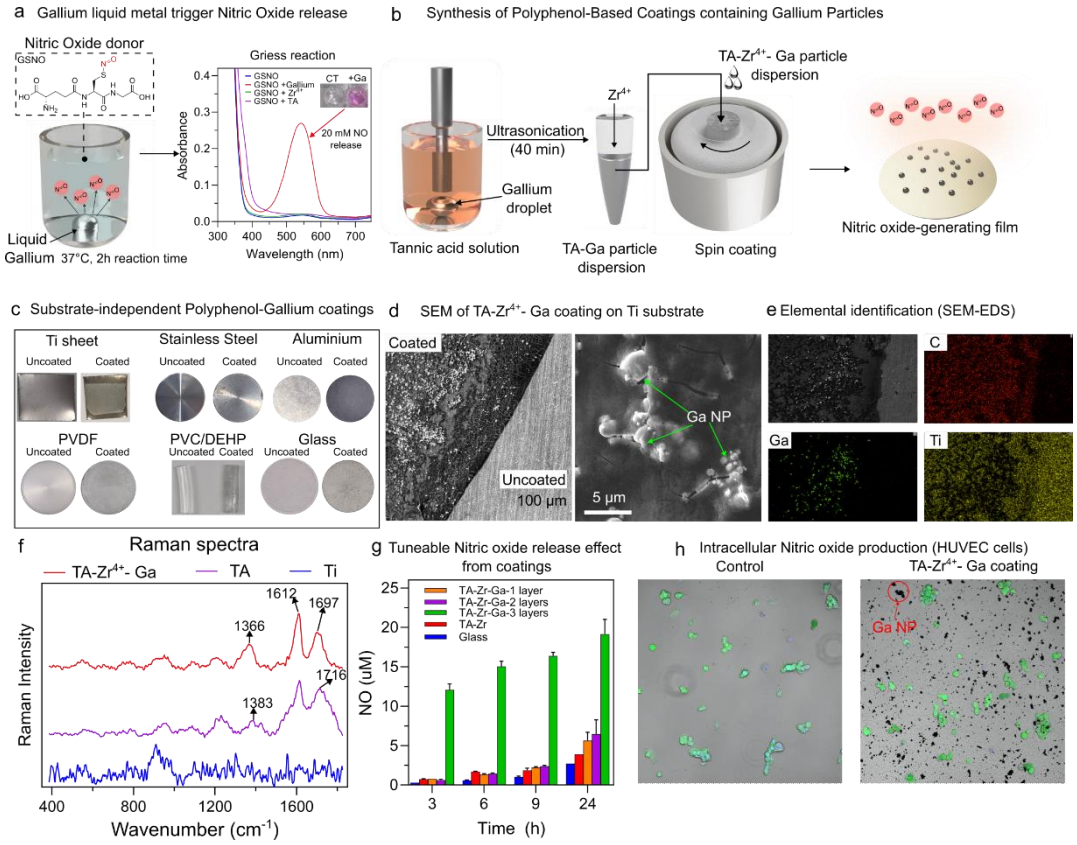

Figure 1: Polyphenol-gallium nanocoatings for tunable nitric oxide release and enhanced biomedical implant performance. (a) Liquid Gallium induces NO release. (b) Synthesis of polyphenol-gallium nanocoatings and (c) their application in various substrates. (d-e) Morphological and (f) spectroscopic characterization. (g) Tuneable nitric oxide release from the polyphenol-gallium coating and (h) Intracellular nitric oxide production.