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Painting without paint via laser-induced plasmonic nanostructuring

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In partnership with the Royal Canadian Mint (RCM), a new laser colouring technique was developed using ultrafast lasers. The colouring of noble metals is initiated by laser ablation. We discuss the creation of nanoparticle arrays on the metal's surface by the cooling of the plasma plume. The ablation is done in air, where the content of the plasma is re-deposited onto the metal's surface. We show that these structures can be controlled to produce any desired colour on the surface of silver, gold, copper and aluminum while preserving purity. Large-scale simulations of metallic nanospheres distributed on a surface by using a bulk plasma model, i.e., Drude with two critical points, which takes into account the interband transition region, well reproduce the colour trends observed in experiments. We present a plasmonic coloured coin of diameter of 21 cm, thickness of 2.5 cm and overall topography of 1.5 cm. The process of generating the colours is fast and reproducible making it viable for large scale industrial applications. We also demonstrate the passivation and colour tuning of the coloured surfaces via the deposition of thin layers of aluminum oxide by atomic layer deposition (ALD).

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