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# Sulfur-Modified Bitumen with Crystalline Surface Shield Against UV Radiation and Moisture

**Background** The United States produces millions of metric tons of elemental sulfur annually, mostly from industrial processes such as oil and gas refining, where sulfur is an undesirable waste product. Due to the recent reduction in allowable sulfur in marine fuel as well as the development of sulfur-rich oil reserves including the Athabasca oil sands, there is significant interest in finding commercially viable applications that consume the increasing supply of elemental sulfur available on the market. At one end of sulfur utilization, inverse vulcanization chemistry can produce sulfur-polymer materials directly from waste sulfur. However, widespread adoption and scale-up of such materials has yet to be realized because their limiting mechanical properties, while environmental concerns remain about degradation byproducts and material end-of-life. **Invention Description** Researchers at Arizona State University have developed sulfur-modified bitumen compositions, including those prepared by combining elemental sulfur and petroleum bitumen. Elemental sulfur can crystallize (or "bloom") on the surface of the bitumen, thereby acting as a shield to protect the bitumen from environmental wear. Interaction of sulfur with bio-oil can be used to prevent sulfur crystallization in the bulk as well as facilitate the gradual bloom of sulfur on the surface, thus driving a regeneration process. If the bloom is disrupted, for example, by an abrasion, a layer of sulfur bloom reforms. Surface bloom can protect underlying layers from ultraviolet radiation damage, and in addition, the hydrophobic nature of the bloom provides a shield against moisture damage. Since bitumen building materials are often sources of potentially harmful volatile organic compounds (VOCs), surface sulfur blooms may also serve as a physical barrier to VOC evaporation. **Potential Applications** • Sustainable infrastructure and construction • Waterproof sealants and binders • Bitumen-based building materials **Benefits and Advantages** • Photoactive sulfur bloom protects underlayers from damaging solar radiation and moisture • Self-healing and hydrophobic surface improves moisture resistance and durability of outdoor construction • Bio-oil and sulfur components can capitalize on waste cooking oil and industrial waste sulfur • Sulfur polymerizes in-situ within bitumen matrix, bypassing the need for costly polymer additives **Related Publications:** • [Sustainability Implications of Regenerative Sulfur Blooms in Bituminous Composites](#) • [Phenolic compounds to amplify the effect of sulfur on Bitumen's thermomechanical properties](#) [Faculty Profile of Professor Elham H. Fini](#)

