Thesis Project Portfolio

Production Plant of Nanoparticle Mineral Oxide Sunscreen

(Technical Report)

The Enabling of Skin Bleaching in Sub-Saharan Africa by Harnessing Socioeconomic Disparities

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2025

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Sociotechnical Synthesis

The cosmetics and skincare industry has become more inclusive and focused on designing products that work for all skin tones. However, this has not always been the case, and the market is still far from perfect. My STS research explores one of the darker aspects of the cosmetic industry, focusing on the adoption of skin bleaching in Sub-Saharan Africa. Through this research, I examine the responsibility engineers have in creating inclusive products, which directly connects to my technical project. For that project, my team and I designed an invisible mineral sunscreen along with its production facility. Our product was specifically formulated with darker complexions in mind, allowing people to protect their skin without experiencing a white cast. While my technical work and STS research approach inclusivity in cosmetics from different perspectives, both emphasize the importance of responsibly designing cosmetic products.

My technical project applies chemical engineering design principles to create a production plant for nanoparticle mineral sunscreen. My capstone team developed the necessary unit operations to synthesize the UV filters titanium dioxide and zinc oxide using direct precipitation methods. We then designed separation units to isolate these mineral oxides, which would later be combined with inactive ingredients such as skincare additives and emulsifiers to produce 5.2 million fluid ounces of sunscreen per year. We determined process parameters that ensured the nanoparticles remained at 50 nm. These are small enough to be invisible on the skin but large enough to avoid absorption into the bloodstream. The goal of our project was to demonstrate a real industry problem and highlight the demand for a solution, specifically the need for invisible mineral sunscreen at an affordable and accessible price point. We hope this work provides a foundation that future chemical engineers can build upon and improve.

My STS research examines a clear example of the lack of inclusivity in the cosmetic industry, which my technical project sought to address. It focuses on how skin bleaching products exploit socioeconomic insecurities by making women feel inferior in their natural skin. I analyze the root causes behind the prevalence of these products and use an STS framework to evaluate how they deepen

inequalities among already marginalized groups. Drawing on Langdon Winner's theory of Technological Politics, I argue that skin bleaching technology functions as a political device that reflects and reinforces biases against darker skin tones while promoting lighter skin as the societal ideal. My research highlights not only the health risks of skin bleaching but also its deeper psychological impacts. The goal of my work is to encourage engineers to design ethically and inclusively, rather than creating technologies that contribute to harmful social divides.

Working on both projects at the same time allowed me to understand the broader importance of designing with all users in mind. After researching and designing the nanoparticle mineral sunscreen plant, I became more interested in exploring inclusivity within the cosmetics market and addressing the problems that still exist. This curiosity led me to investigate skin bleaching for my STS research project. The overlap between both projects gave me valuable insight into how to be an ethical and inclusive engineer, considering product and process designs that benefit all communities without disadvantaging others.