Environmental Responsibility in Cosmetics: The Case of Microbeads

By Stephenie Smulligan-Maldanis, Nerac Analyst

Brilliant, white teeth and clear skin: it seems like Americans are in constant pursuit of youth and beauty. A recent poll found that over half of women use up to four beauty products a day and spend $426 billion a year on these products.(1) A popular part of a comprehensive skin-care regime is exfoliation. In recent years, facial scrubs, teeth whitening toothpaste and other products containing abrasive microbeads have become quite popular. Due to microbeads' smooth edges and uniform round size, products including microbeads have become very popular as a gentle option for exfoliation. Unfortunately, the same properties that make the beads so beloved have now become their downfall.

Microbeads: What is the problem?

According to 5 Gyres, a non-profit organization aimed at reducing plastic pollution in the world's oceans (2), after their use, microbeads travel into public and private sewage treatment systems. Due to the size and density of the beads, they are able to escape during sewage treatment or in the case of septic tanks, the beads are expelled directly into the environment. Once released, microbeads are finding their way into bodies of water, where they can be ingested by fish and other organisms. Perhaps more concerning, the beads have been shown to adsorb pollutants along the way. This results in uncertain consequences for the health of the organism itself as well as those that may enter the human food supply.(3)

A recent publication by 5 Gyres, in collaboration with researchers from SUNY at Fredonia, reported their study on microplastic pollution of the Great Lakes Region (4). Researchers found high concentrations of microplastics that were similar in size, shape, texture and composition, providing circumstantial evidence that microbeads are not being adequately captured in sewer treatment. Research such as this has lead to possible state-wide bans of microbeads, as well as creating a major impact on product manufacturers. Companies such as Procter and Gamble, Unilever, Johnson & Johnson and Colgate-Palmolive have agreed to phase out micro-beads in their products (5).

Finding a suitable replacement

With microbeads potentially on their way out, the question remains, what will take their place? News reports and social media posts refer to ongoing research for biodegradable replacements, and the use of materials like cellulose and hydrogenated castor oil/jojoba oil (6).

A grant to researchers at the Virginia Institute of Marine Science has resulted in a partnership aimed at reducing pollution from microplastics (7). Researchers Dr. Kirk Havens, Dr. Donna Bilkovic, Dr. Jason McDevitt, Charles Bott and David Holbrook are exploring the use of biopolyesters produced by several types of soil-dwelling bacteria. These "biodegradable microbeads" appear to have both the properties needed for

use in cosmetic products and are wastewater treatment-friendly. Since the beads sink in water, they are more likely to stay in and biodegrade during water treatment. A recently published patent application, US 20140026916, appears to disclose some of this work. The inventors report a method for the reduction of pollution in aquatic systems by incorporating polyhydroxyalkanoate microbeads into personal care formulations.

In February, 2014, France-based Lessonia announced Celluloscrub, an innovation to replace polyethylene beads in cosmetics (8). Citing worldwide approval for use without restriction, Celluloscrub is reported to be stable with excellent skin tolerance, while being renewable and biodegradable. Celluloscrub is made from wood pulp, thus is subject to degradation by natural mechanisms, including bacteria or light.

Adjacent Technologies: Potential new avenues

Many companies that utilize plastic microbeads in their products have already committed to their removal, and with multiple replacements seemingly on their way to market, what potential opportunities could be found in existing literature? What sorts of biodegradable microspheres have already been disclosed? Are any of these suitable to build off of for a replacement in personal care products? *Since various types of microbeads are used in diverse markets, such as pharmaceuticals and paints, where else are "biodegradable microspheres" being reported?*

While microparticles are often designed as encapsulating devices, patent WO 200009084, assigned to Andaris/Quadrant Healthcare, describes a biodegradable microparticle gel composition (9). The gel is described as including a wall-forming material that is relatively insoluble at physiological pH. The microparticles of this invention may be a protein, such as casein.

Similarly, EP 563876 describes biodegradable microbeads for pharmaceutical and cosmetic uses (10). The inventors cite the use of natural proteins, such as gelatin, albumin or casein with glyceraldehydes as a cross-linking agent. More recently, a 2014 US patent application assigned to Covidien, discloses multi-encapsulated formulations made with oxidized cellulose. The inventors appear to describe a multi-layer microsphere containing multiple bioactive agents.

A patent literature review also revealed that some innovation for a plastic microsphere replacement in cosmetic scrubs has already been reported. A 2011 US patent application assigned to Micropowders describes a novel polymer powder composition suitable for personal care and cosmetic compositions (11). The inventor discloses the use of biodegradable polylactic acid which can be used in compositions like body scrubs, and reports the same performance as scrubs made with synthetic polymer particles.

Another one, US 8637440, published in January 2014, describes a biodegradable personal cleansing composition (12). The inventor describes the use of a stable and biodegradable soy meal based polymer. The vegetable based particulate is added to mechanically scrub the skin of the user.

How can Nerac help?

At first glance, it is uncertain if these example existing technologies could potentially offer suitable properties, such as texture/visual appearance or compatibility with the formulations currently using microbeads, however Nerac literature and patent research such as this can provide a baseline. Furthermore, Nerac may be able to

locate potential partners, including University researchers, laboratories, licensing and other collaborative opportunities to augment ongoing research and development.

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While background research is imperative, at the beginning of a project, ongoing monitoring of publications is crucial. United States patent applications take approximately 18 months to publish. Despite the fact that Lessonia doesn't appear to have their Celluloscrub product protected at this point, this application could publish at any time, with dramatic implications for anybody else working on similar technology.

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About the Analyst

Stephenie Smulligan-Maldanis

Stephenie Smulligan-Maldanis collaborates with Nerac clients to advance their chemical research and development needs. She applies her expertise in the fields of materials science, organic chemistry and inorganic chemistry to help companies find solutions involving transition metal catalysis, olefin polymerizations, surface functionalizations, ceramic design, and analytical characterization methodologies. Ms. Smulligan-Maldanis was a bench chemist at Heatbath Corp., a metal finishing and electroplating company, where her main focus was on the research and analysis of metal finishing chemistries. Those included acid pickling, conversion coatings, electroless nickel and lubrication films. She also taught chemistry for several years at the high school and university levels. She is particularly knowledgeable in the areas of materials science, including coatings and adhesives, synthesis and characterization of organic and inorganic compounds, and polymer chemistry, including catalyst design and polymer characterization methods. In addition, Ms. Smulligan-Maldanis specializes in chemical abstracts and structure/Markush searching.

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