

**ScotCHEM-IBioIC Workshop:**

**Smart Sustainable Materials**

**17 December 2018**

**World Café Workshop Summary**

**Introduction:**

As part of the workshop program, attendees took the opportunity to discuss six critical questions around five themes in smart, sustainable materials. The themes covered were design for recycle, bio-based solutions for new functionality, bio-routes to conventional materials, biodegradability, and smart packaging. The six questions were designed to identify challenges, necessary skills and resources, barriers, relevant research questions, routes to market or implementation, and project outlooks. The summary below is organized around these questions.

**Challenges:**

A number of important challenges were identified across the themes, with the most common being the costs—monetary, environmental, and social— of smart materials. Consideration needs to be given to the costs of feedstocks, (assuming availability and efficient conversion), materials and process development, testing and life-cycle analysis, etc. Further, it is important to consider who will pay these costs; are these smart materials, in fact, desired when these costs are passed on to the end user?

Discussion on costs segues neatly into material performance. Materials that perform only as well as their current alternatives will face an uphill battle if not relatively cheap or environmentally friendly. Materials that are more expensive will be expected to either possess added functionality or demonstrate a significantly diminished environmental and societal costs. Performance was also discussed in the context of high-throughput screening for performance and material property testing, which currently occurs on the months-to-years timescale.

A lack of strategic focus on short- and long-term goals was also identified as a challenge. Coherent messaging on the materials, and properties thereof, is needed to plan for industries and researchers to work toward ambitious targets. Other key challenges identified are as follows: the significant environmental toxicity of non-bio-based materials and the lack of availability of pilot and scale-up facilities.

**Skills and resources:**

There was confidence around the topic of having the right skills and resources available to attain a suite of smart, sustainable materials. However, many noted that multidisciplinary partnerships and/or partnership across industry and academia are absolutely critical to success. Many of the skills and resources are in place, but it is critical that they do not exist in isolation. Gaps in skills and resources of note were in recruitment of fermentation expertise and whole-process development skills.

**Barriers:**

The barriers to work on novel materials are many. While the development of sustainable materials is undoubtably an important objective, many felt that the current level of funding available did not rise to the level of the challenge. Reiterating from the challenges section above, many noted that the lack of coherent focus, well-defined demands, or clear definitions (e.g. bio-based, biodegradable, sustainable, etc.) can result in slowed progress toward targets.

From a societal standpoint, public opinion and regulation around the use of genetically modified organisms was identified as a significant barrier. Education on the genetic modification will prove to be a challenge as demonstrated by a recent letter to Nature Human Behavior titled “[*Extreme opponents of genetically modified foods know the least but think they know the most*](https://www.nature.com/articles/s41562-018-0520-3.epdf?referrer_access_token=T4jm05O09vV1ailvrxwh4tRgN0jAjWel9jnR3ZoTv0NCPz-kWDa8SCyuAJLdVCIz2ISGO2G0jLidVKBpSJP90X2Ze37IY_xhfvHFGWhgcA7-UUoLHl8Er9QHz1CAPto2KNm_6yHitVA7JoMwkFX67jagDT6LOxDCF5R94xfGsFn9rb74grZguv1-C6w0G_wphryx0Y-zz37VkqBrTBO8QSoXL575z7JHB9vqkgmhzMpNL0TH2YPfZDglPp_5qITAc48FpmMKB1XoqmaiJMv1eKxNQJrzE9EXiNnN_Xpfno4%3D&tracking_referrer=www.theguardian.com)*”*. Focusing on this specific sector, it was noted in the case of recycling that the person with the least knowledge (the end-user) has the greatest responsibility in the chain of events necessary to achieve the desired outcome.

From an industry perspective, barriers identified included the resistance to switch to new materials, sometimes intertwined with long-term contracts between suppliers and material-users. The resistance is created by many factors including inertia and risk of failure (technical and market) of new materials. Furthermore, existing supply chains are built on large capital investments so materials which “drop-in” to existing processes would be favoured.

**Research questions**:

A number of research questions came out of the discussions. A selection is listed below:

* What new functionalities can be imparted to novel materials to make them superior to their alternatives?
* How can the speed and consistency of bioproduction be improved?
* What are the products of the degradation of these novel materials? Is there the potential for unintended consequences, and how might those be mitigated?
* Can we understand the comparability of different PVCs?

**Routes to market/implementation:**

A number of ideas around routes to market and implementation were identified. Two separate groups brought forth the importance of thinking about layered materials in packaging applications and subsequent recycling/degradation. A route to market might include the development of high-performance biodegradable barrier coatings and degradable tie layers for multilayer films. Separately, another implementation route with a focus on ‘turn-on’ decomposition and biodegradation was proposed. A central identification database of plastics and material was identified as a potential tool to aid implementation of recycling programs.

**Project outlook:**

Project outlook questions were left for the end of discussion, with the need for consensus around standards and definitions again identified. The importance of bringing the right people, skills, and resources was again echoed, with a consortium approach proposed as a solution. Building strong, diverse project teams will be a critical component to answering the call for smart, sustainable materials.