Guest Editorial

Shechtman International Symposium

The 2014 – Sustainable Industrial Processing Summit (SIPS 2014) was exclusively dedicated to the lifetime achievements of the 2011 Nobel Prize Laureate in Chemistry Dr Dan Shechtman, Professor at Technion Israel Institute of Technology and at Iowa State University USA, and named Shechtman International Symposium.

Professor Dan Shechtman is famous for his discovery of the quasi-crystals about 35 years ago, which he obtained through the fast quenching of an aluminium manganese alloy. This discovery was against the established scientific beliefs of the time that only recognised crystals and amorphous phases. Nobody accepted this new quasi-periodic crystal structure he had found, and his thinking was not only rejected but even ridiculed by some experts in the field. However Professor Shechtman did not give up and courageously defended his findings. His discovery finally reached wide recognition about 20 years later, which eventually culminated in the award of the Nobel Prize in Chemistry some 30 years later. After all, one bold materials engineer had changed the fundamental physicochemical understanding of crystalline phases. Today quasi-crystals have found important applications in a range of fields, for instance, as a non-stick, rust-free and heat-resistant material in frying pans and as a key component in modern technologies such as LED lighting and 3D printing. Over the time Professor Shechtman has widened the scope of his academic work, developing an interest in the concepts of resource management and sustainability, and also encouraging in particular younger colleagues to take on the challenge of technology transfer and research commercialisation.

Professor Dan Shechtman delivering a plenary lecture at the Symposium held in his honour

The Shechtman International Symposium not only covered the science of quasi-crystals but also addressed the concepts of sustainability in contemporary research, development and industrial practice, with a view to mineral processing, extractive metallurgy and materials engineering. In line with the scope of the *Journal*, we are featuring in this Special Issue a set of conference contributions that are at the heart of this topic, relating to the recycling or reclamation of key elements from substantial waste streams or end-of-life products.

In an effort to introduce the fundamental concepts of sustainability Pech-Canul and Kongoli, in the opening article, establish the modified paradigm of materials science and engineering, by showing that the well-known cause-and-effect relationship of 'processing → structure → property → performance' needs to be expanded by adding the missing link of 'reutilisation/recyclability' so as to complete the cycle and ensure fully sustainable materials processing. The following articles then present a diverse selection of ongoing research and development activities, all with the goal of ascertaining the future sustainability of crucial technologies.

Hydrometallurgy is an essential feature of the first five of these contributions. Aromaa *et al.* tackle the processing of dust that arises throughout the various stages of stainless steel making, aiming at selectively leaching out zinc to allow feeding the dust back into the steel making process. Stuhlpfarrer *et al.* herald the inception of urban mining by putting forward a closed-loop treatment of waste electrical and electronic equipment (WEEE), especially hard disc drives, as these constitute a source of several strategic metals including some rare earths. Tunsu *et al.* describe their assessment of the recycling potential of discarded fluorescent lamps, targeting primarily the retrieval of a variety of critical rare earth metals. Kulcsar *et al.* foresightedly present their initial results on the recovery of tin from lead-free solders by electro-refining and -crystallisation, while these are taking over from the recently banned lead-based materials. Pagnanelli *et al.* introduce their ambitious concept of a process suitable for the simultaneous handling of different types of photovoltaic panels, which will soon make up a major global waste stream.

High-temperature routes using molten salts, even though in general more expensive, need to be adopted in cases where hydrometallurgical methods are not suitable for the recycling challenge at hand, as is exemplified by the final two studies. In one of these, Liu *et al.* investigate an alkali salt fusion process to recover amphoteric metals, such as tin, lead, zinc and aluminium, from waste printed circuit boards (PCBs). In the other one, Konishi *et al.* depict a molten chloride electrolytic cell for the separation and reclamation of neodymium, dysprosium and praseodymium from Nd–Fe–B scrap magnets.

Of course many other contributions would have deserved inclusion in the Special Issue but space constraints prevented this. The full range of conference presentations is available in the proceedings, edited by F. Kongoli and published by FLOGEN Star Outreach™ as '2014 – Sustainable

Published by Taylor & Francis on behalf of the IOM3 and the AusIMM
DOI 10.1080/03719553.2016.1244891

Industrial Processing Summit & Exhibition/Shechtman International Symposium'. A detailed conference report is provided at http://www.flogen.org/ShechtmanSymposium.

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