

The Partnership of R&D Groups and Industries in Promoting Green Chemistry and Chemical Process in Taiwan

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Taiwanese government and industries formed a partnership and devoted much effort on Green Chemistry and other extended applications in the past decade. The basic definition of Green Chemistry, namely, more efficient reaction, easier to be used process and environmentally benign production perfectly describes the main features of three stages (basic research, applied research and industrial applications) of Green Chemistry in Taiwan. NSC and MOEA supported universities and applied research institutes to play the roles of initiator, catalyst and partner for local industries in the application of Green Chemistry, Cleaner Production, Waste Minimization and Resource Recovery.

Introduction. Sustainable production and consumption has been urged by the 2002 World Summit on Sustainable Development (WSSD) as one of the keys for the promotion of sustainable development in all countries in the 21st century. Being a country with dense population and shortage of natural resources, Taiwanese government and industries formed a partnership and devoted much effort on Green Chemistry and other extended applications such as Cleaner Production (CP), Waste Minimization (WM) and Resource Recovery (RR) in the past decade. Actually, the basic definition of Green Chemistry, namely, more efficient reaction, easier to be used process and environmentally benign production perfectly describes the main features of three stages of Green Chemistry studies and applications in Taiwan as the following:

1. Basic Research – study the innovative and more efficient chemical reactions.
2. Applied Research – focus on the feasibility of scale-up those easier to be applied “greener”

chemical reactions and processes.

3. Industrial Applications—devote to the adoption of environmental benign processes, including eliminating the usage of toxic chemicals, cascade usage of solvents, reuse and recovery of materials.

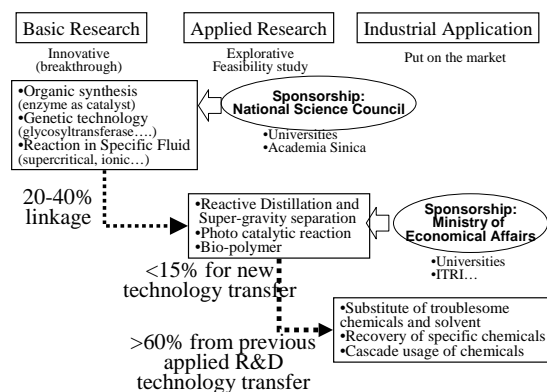


Fig. 1 Technological linkage of the Green Chemistry in Taiwan

Figure 1 shows the technological linkage among three tiers of the promotion and practice of Green Chemistry in Taiwan – i.e. the integrated efforts of basic study, applied research and industrial application

Basic Research. National Science Council and

Academia Sinica provided the funding and infrastructural support (including the sharing of world-class instrumentation) for academia in Taiwan to explore the innovative basic Green Chemistry research. The ultimate intention of the planning has been concentrated on the technological breakthrough, which can be compatible and benchmarked with the leading international research communities. Therefore, the main fields were focused on the following aspects:

1. The more efficient organic synthesis—especially the utilization of enzyme as catalyst to accelerate the governing reactions generating key chemicals with fewer steps and less wastes.
2. Adaptation of genetic technology to explore the breakthrough for biosynthesis in producing renewable bio-chemicals or biodegradable materials.
3. Systematically study the most feasible domain of chemical reactions in special (supercritical or ionic) fluids to dramatically reduce the usage of hazardous solvents.

Applied Research-Ideally, the intermediate applied R&D has the mission to sustain the achievements from basic research and followed by the “field” applications of the successful demonstrated projects to the industries. However, more than 2/3 of the results from basic studies had not been extended even to the stage of applied research after the consideration of “cost effectiveness” of those topics. The Ministry of Economic Affairs (MOEA) is the major authority in Taiwan to support applied R&D projects with respect to production technologies in all industries. Most

programs were granted to some research organizations (Industrial Technology Research Institute, ITRI, is the major receiver) and few universities, and were focused on the following subjects in the past five years:

1. Reactive distillation and super-gravity separation—integrates chemical reactions and/or separation processes to reduce the magnitude of productions and enhance the reaction yields.
2. Photo-catalytic reaction—including the modification of photo induced catalysts to utilize more energy from natural light and to design innovative reactors to increase the efficiency.
3. Production of biopolymer—scale-up the demonstrated studies from fundamental researches to explore the feasibility of the production of biopolymer by using starch and agriculture wastes as raw materials.

Industrial Application. Environmental pressure initiated from governmental authorities and customers is still the major motivation for local industries to adopt Green Chemistry and related technologies in their production activities. However, only small portion of the “environmental friendly” technologies used by the industries in Taiwan can be strictly classified as “Green Chemistry”. On the other words, most of the environmental benign technologies used by local industries were based on the relative broad definition of “Cleaner Production” and had been transferred from R&D institutes like ITRI. Following are some typical subjects and examples:

1. The substitution of environmentally

“troublesome” chemicals and solvents—one of the typical cases is the substitution of polyvinyl chloride (PVC) film by relatively eco-materials such as forming PE/EPDM blend in the production of electrical insulation tape.

2. Recovery of some specific chemicals—especially recycle and purify those expensive specialty chemicals in IC and LCD industries to be reused in the original process.
3. Cascade usage of chemicals—many kinds of solvent used by hi-techs can be utilized as raw materials in other chemical industries after certain stages of separation and purification.

The Management of Linkage. The applied research projects of R&D institutes and few universities granted by MOEA play a major role in promoting the ideas and practices of Green Chemistry in Taiwan. Figure 2 shows the two dimensional approach for the promotion of “Cleaner Production (CP)” technologies.

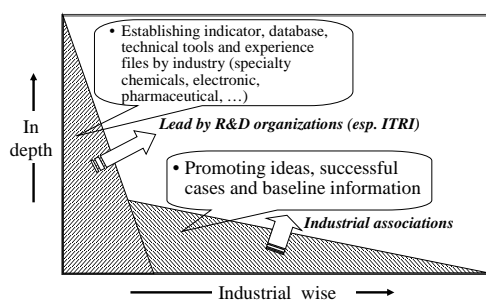


Fig. 2 The two dimensional approach for the promotion of cleaner production technologies by MOEA in Taiwan

MOEA supported ITRI to establish indicators, database, technical tools and experience for case studies since 1996 to build the infrastructure for the extensive application of CP/GP. In the mean time, MOEA also help those industries facing

stringent environmental regulations and pressures to form technological alliances to share information and experiences.

Green Supply Chain for Electronic Industries.

Recently, the environmental concerns of electrical and electronic equipment of the European Union created a new wave of “Green Supply Chain (GSC) Movements” in Taiwan. This is intended to integrate the environmental protection strategies and logistics in the supply chain to respond proactively to the new trend of green consumerism. Since GSC is a new concept to most of the small and medium-sized enterprises in Taiwan, a very unique “Center-Satellite demonstration project” collaborated by governmental agencies (different branch offices in MOEA), research organizations (lead by ITRI) and industrial associations, has been adopted for the promotion of GSC to the selected electronic companies.

Actually, the new movement of the green supply chain management induced by the European Union’s RoHS Directive creates tremendous pressures for the electrical and electronic industries in Taiwan during the past year. However, as the world leading production base for many of the electronic products, the partnership promoted by Taiwanese government shows local companies have the capabilities not just to passively meet the green requirements from international buyers but also to actively steer to the new trend of green consumerism.

Conclusions. The uniqueness of historical development of small and medium sized enterprises dominated economy pushed Taiwanese government to take the responsibility of promoting the partnership of R&D groups and industries in practice green chemistry and chemical processes. In the past few years, NSC and MOEA supported universities and applied research institutes to play

the roles of initiator, catalyst and partner for local industries in the application of Green Chemistry, Cleaner Production, Waste Minimization and Resource Recovery. However, we still need more proactive activities to accelerate the practice of some innovative achievements developed by those organizations in order to keep in pace with the international trend of “Sustainable Industries”.