European Union's Fifth Framework Programme Features Materials Research

Edith Cresson

The European Union (EU) unites 15 European countries[1] in order to promote economic and social progress among the peoples of Europe and to coordinate national policies on economic, security, justice, foreign, and home affairs. A continuously evolving research policy has become an "issue of state" in all advanced, industrialized countries since 1945, both in Europe and in the rest of the world. Initially, in the 1950s, in countries such as France, the United Kingdom, and the United States, research policy was largely devoted to defense technologies. Progressively this turned toward a "technology push" philosophy in the 1960s and 1970s, exemplified by the construction of large accelerators (e.g., at CERN), or by large space research programs. Since that time, "societal needs" have started to dominate the rationale for government support of research programs, which is the case at the EU as well.

The EU supports research throughout the Union's member states and certain Associated States[2] by means of its five-year Framework Programmes. The treaty establishing the European Union (the Maastricht Treaty), signed by all the then member states in 1992, explicitly references the establishment of such multi-annual Framework Programmes, acknowledging and underscoring the importance of a coordinated Research Policy within the EU.

The actual contents and details of each Framework Programme are developed and proposed by the European Commission, the executive arm of the EU, in wide-ranging consultation with all interested parties. The Commission proposal is then debated, modified, and ultimately adopted by the European Parliament and the European Council (representing the governments of the 15 member states) in a complex process known as co-decision. The Framework Programmes' multi-annual character provides a highly beneficial degree of certainty and continuity for the scientific community—both in terms of objectives and means.

Once agreed, the execution of the Framework Programmes is implemented by the European Commission. These programs support a large range of research from basic science to applied, precompetitive research of interest to European industry. Research projects are awarded to multipartner, multinational consortia, usually bringing together universities, research centers, and industries, with the objective of bridging the gap between these different types of partners. As a general principle, all research funded by the European Commission has to have a clear European interest and added value, both in terms of the research partners involved and in terms of the objectives of the work carried out.

The Fifth EU Framework Programme for Research and Technological Development: 1998–2002

The Fifth Framework Programme, scheduled to run from 1998 to 2002 and with a budget proposed by the European Commission of 16.3 billion ECU (~18 billion U.S. dollars), represents a break with the past in terms of its philosophy, structure, and strategy. The preceding Fourth Framework Programme (1994–1998), which is coming to an end, was composed of 18 subprograms (called Specific

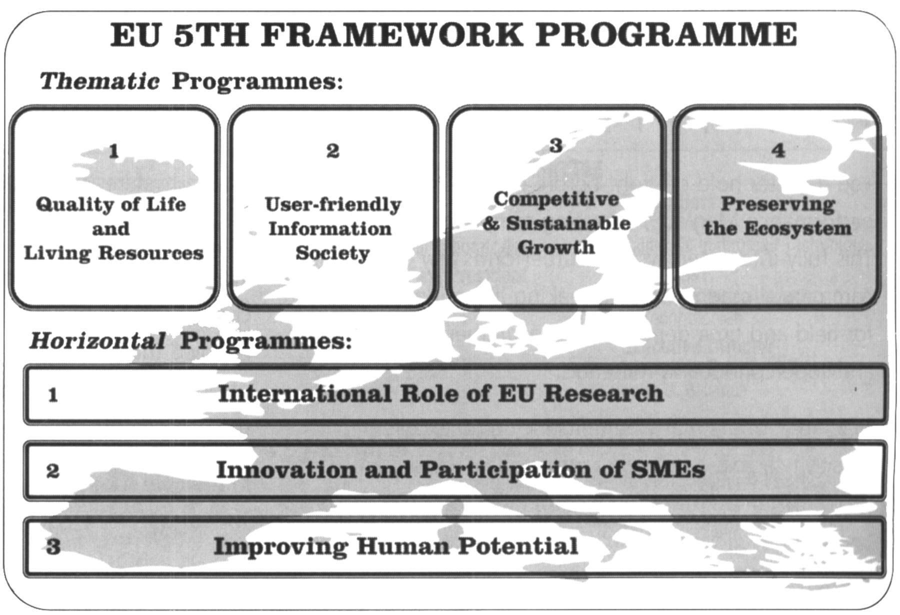

Figure 1. Simplified structure of the European Union's (EU) Fifth Framework Programme. Four large Thematic Programmes focused around major societal challenges, together with three cross-cutting Horizontal Programmes, assures a coherent, unified approach to addressing the needs of EU citizens. SMEs stands for Small and Medium Enterprises.

[1]European Union member states are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, and the United Kingdom. Negotiations are underway to further expand the Union to central and eastern European states and Cyprus.

[2]Associated States participating in the Fourth Framework Programme are Israel, Iceland, Liechtenstein, and Norway.

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Programmes) on specific topics including information technology (ESPRIT), telecommunications (ACTS), and industrial and materials technologies (IMT). Each Specific Programme was individually planned and implemented, with a strong underlying emphasis on promoting economic and industrial competitiveness in the EU. This emphasis on competitiveness is a direct reflection of the ideas circulating at the beginning of the current decade when it was planned.

With the start of a new millennium just ahead, Europe faces societal challenges which such a simple competitiveness-based approach cannot address. Natural resources are limited and an approach based on environmentally friendly, sustainable technologies is becoming ever more important. In addition, the information society is proceeding at a rate the citizen finds hard to grasp; more user-friendly information technologies are clearly required.

These problems are multisectoral and cannot be approached in a piecemeal manner and hence a global approach is needed and is reflected in the simple structure proposed in the Fifth Framework Programme (see Figure 1) where four, integrated, problem-solving Thematic Programmes replace the 15 currently existing Specific Programmes. These Thematic Programmes are designed to help

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- improve the quality of life and the management of living resources,
- achieve a user-friendly information society,
- increase the prospects of competitive and sustainable grown within the EU, and
- preserve the ecosystem, achieving a more rational use of energy and the environment, and improving the prospects of a sustainable development in society.

To complement these Thematic Programmes, three Horizontal Programmes will be implemented on International Role of EU Research, Innovation and Participation of Small and Medium Enterprises, and Increasing Human Potential and Resources. The activities of these Horizontal Programmes will span all the areas concerned by the four Thematic Programmes.

Materials Research Within the Fifth Framework Programme

The new Thematic Programmes will provide a large enough umbrella to tackle societal problems with a rational, coordinated, and focused approach. Compared with the previous Framework Programme, the new Thematic Programmes are designed to simplify and streamline the planning and administration within the European Commission, whose duty it is to execute them.

The activities of each Thematic Programme will concentrate on a series of Key Actions addressing specific problems at the European level. For example, the third Thematic Programme (see Figure 2) on Competitive and Sustainable Growth includes four Key Actions on Products, Processes, and Organization; Sustainable Mobility and Intermodality; Land Transport and Marine Technologies; and New Perspectives in Aeronautics.

In order to help the development of European technological capacity; stimulate the flow of ideas, knowledge, and applications; and to complement and support the key actions, the four Thematic Programmes will also include a series of research and technological development activities of a more long-term, generic nature. In the third Thematic Programme, such generic research will include new materials and their production and processing.

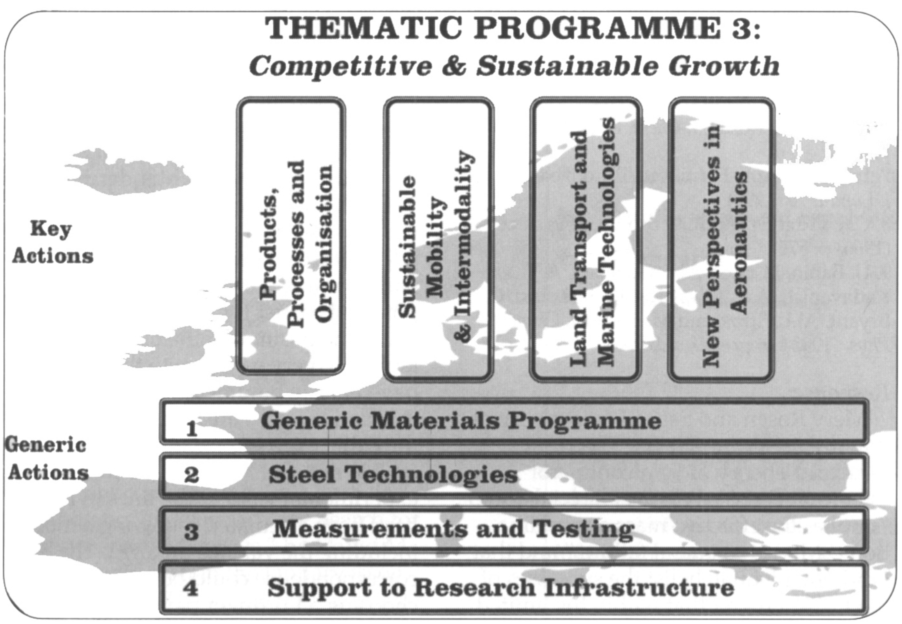

Figure 2. Materials research is specifically addressed within the third Thematic Programme "Competitive and Sustainable Growth": The generic research under this Thematic Programme guarantees a high profile for materials research within the Fifth Framework Programme.

Structure and Approach of the Proposed Generic Materials Research Programme

Materials have always been central to human growth, prosperity, security, and quality of life. Especially in the last decades, the fields of materials science and engineering have begun to take shape and to achieve recognition. This has occurred just as the materials field itself is expanding greatly and contributing significantly to society. Without new high-performance materials and their efficient production, the world of modern devices, machines, computers, automobiles, aircraft, and communication equipment could not exist.

Materials research played a prominent role within the Fourth Framework Programme (1994–1998), and was specifically covered within the program on Industrial and Materials Technologies (IMT) with a total budget allocation of ~600 million ECU (~700 million U.S. dollars). In the Fifth Framework Programme, generic research related to materials will maintain this prominent role with a similar level of funding proposed. Although the exact structure and composition of the generic research on materials is still under discussion, it aims at sustaining the development of new and improved materials and related technologies. At present, three distinct activities are envisaged:

▪ *Materials with wide-ranging applications:* The aim is to promote research on the most promising avenues for improving the functionality and performance of existing materials, and the development of new materials with distinctly new or radically improved characteristics.
▪ *Materials production and transformation processes:* As the production and transformation processes of materials have a major influence on cost and materials properties, research will focus on technologies which can ensure quality, reliability, and cost effectiveness.
▪ *Sustainable use of materials:* A growing need exists for the development of sustainable technologies. Research will focus on the environmental and safety impact of new materials and on recycling materials.

Conclusion

New and advanced materials are a fundamental and key technology in any advanced society. The development of advanced materials is a horizontal, cross-cutting technology affecting many areas of the economy. The Fifth Framework Programme of the EU recognizes the importance and cross-cutting nature of materials research and will include a specific activity on generic materials research and technological development.

Further information on EU Research Policies can be found on the EU website http://europa.eu.int/pol/rd/en/info.htm and on the CORDIS RTD information service at http://www.cordis.lu/fifth/home.html.

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Letters to the Editor

Effective Mass Approximation Revisited

To the Editor:

In an article in the February 1998 *MRS Bulletin*, p. 35, Alex Zunger gives an overview of the direct diagonalization method (DDM) for calculating the electronic structure of quantum dots, presents some results of that approach, compares them with 6-band effective mass approximation (EMA) calculations and implies the EMA is a general failure. We do not share the author's conclusion. Rather, we remind him that the 6-band EMA has been spectacularly successful in describing absorption,[1] hole burning,[2] and photoluminescence excitation spectra[3,4] in CdSe quantum nanocrystals, has given a quantitative description of the Stokes shift of the resonant photoluminescence and the magnetic field dependence of the fluorescence decay time,[5] and magnetic circular dichroism experiments.[6] The assignment of electronic states based on the EMA provides the foundation for almost every description of electronic structure in quantum dots.[7] The 6-band model, however, is not appropriate for narrow and moderate bandgap semiconductors; rather, one must use its extension to the 8-band EMA[8] which takes the coupling between valence and conduction bands into account. Indeed, we have found that even in narrow gap InAs nanocrystals, this model is very successful in describing transition oscillator strengths and the structure of the absorption spectra.[9] In order to claim accepted standing as a legitimate model for describing the properties of quantum dots, it is encumbent for the DDM to at least show that it produces good physical values for those bulk parameters—including the Kane matrix element—that strongly affect the level structure in these dots.

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Response:

Merv Rosen and Sasha Efros comment that my review article on "Electronic Structure Theory of Semiconductor Quantum Dots"[1] (February special issue) "implies the effective mass approximation (EMA) is a general failure," and that I did not adequately list the successes of the EMA. I regret that within the limited space and scope of a short review paper in the *Bulletin* I could not cite more than four of their articles.

As to the adequacy of the EMA, my research over the past few years had shown me that because the EMA builds into the Hamiltonian the correct physical symmetry of the system at hand, it can achieve good agreement with experiment via judicious selection of its parameters. It thus provides a useful representation and a practical interpolation scheme. However, good agreement with experiment does not always imply good theory. Indeed, some of the (Luttinger-Kane) parameters of the multiband EMA are not physical observables in their own right, but have meaning only in the context of a given, highly simplified model. Thus, these parameters are not "measured." Furthermore, in some cases the EMA parameters are adjusted *de facto* to fit the experiments they claim to explain theoretically. For example, consider **k·p** calculations on CdSe dots: Norris and Bawendi[2] say, "We use standard nonlinear least-squares method to globally fit the experimental data...our fitting routine adjusts three parameters: the Luttinger band parameters γ^1 and γ^2...and the potential barrier for electrons." Efros et al.[3] say, "The position of the quantum size levels are very sensitive to the valence band energy parameter; those used for calculation...give the best description of the CdSe microcrystal absorption spectra." Wind et al.[4] say, "Fig. 1 shows the experimental values...the lines in Fig. 1 have been calculated following a model including the valence mixing....The best correspondence could be obtained [by] choosing a Luttinger parameter γ = 0.38...." Since the EMA theory is explicitly fit to experiment, it cannot examine the legitimacy of either its successes or its failures.

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