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Lithium batteries R&D activities in Europe

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Abstract

In order to evaluate the research activity on lithium batteries in Europe, a short questionnaire was sent to R&D organisation in Europe. A short survey was established from the 50 answers received from public laboratories, which are estimated to represent about 80% of the actual efforts, not including the private organisations and battery companies. From the results, it can be stated that this activity increased by more than 40% for the last five years. More than 90% devoted to rechargeable systems, the main research subjects are on positive materials, supported by a high level solid state chemistry. The research work is largely application-oriented, and supported by important funding programs of the European Commission, in cooperation with manufacturers. © 1999 Elsevier Science S.A. All rights reserved.

Keywords: Lithium batteries; R&D; Europe

1. Introduction

The purpose of this short survey is to get some figure of the amount of R&D work devoted to lithium batteries in Europe. In order to gather the maximum of information, a questionnaire was sent to about 400 addresses from the mailing list of the International Meeting on Lithium Batteries, which contains all the major R&D organisations interested on Lithium batteries. The number of people, number of publications and number of patents were the indicators chosen to measure the activity. Beside identification and some description, the questionnaire aimed to distinguish between the various subjects of work. Although the lithium battery production is much smaller than in Japan and far East and probably in US, the manufacturing activity is still quite significant in Europe, with companies of different sizes, addressing a wide range of products, from small coin cells to large batteries, as primary or secondary batteries. Associated with this manufacturing, most of these companies devote a large part efforts to R&D work, often with funding from the European Commission. Like the public R&D organisations, they received this mail. However, battery companies were very reluctant to release the required information. This is quite understandable, as the company strategy could be easily deduced from the answers. Although some answers were complete, the data were not sufficient to make a fair analysis. Consequently, this survey only deals with the public organisation, mainly universities. It must be considered as describing Research activities more than Development, which is generally made by the battery companies, or some private organisations. About 50 answers were received, which can be considered as a good ratio, most of the addresses not concerning people or laboratories actually making R&D work. However, it is estimated that this would represent about 80% of the actual activity.

2. Survey results analysis

The total number of people in Europe, working exclusively on this subject is about 280. This represent a 43% increase, compared to what it was 5 years ago. Table 1 shows that rechargeable lithium represents now 94% of this activity, primary lithium having comparatively decreased during that period of time.

Table 2 represents the people repartition between countries. Some countries were associated to have a more comprehensible table. The largest contribution comes from France. Even if the answering might have been more

Table 1
Summary of people distribution during the last 5 years

Number of people	1993	1998	Variation
Rechargeable Li	163 (84%)	263 (94%)	61%
Primary Li	32 (16%)	16 (6%)	−50%
Total	195	279	43%

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Table 2
People distribution by countries

	Country						
	DK + SW + NL	F	D + CH + SL + A	I	RU + UK + BU	ES + P	UK
People	26	87	48	35	45	18	21
%	9%	31%	17%	13%	16%	6%	7%

DK: Denmark; SW: Sweden; NL: Netherlands; F: France; D: Germany; CH: Switzerland; SL: Slovenia; A: Austria; I: Italy; RU: Russia; UKR: Ukraine; BU: Bulgaria; ES: Spain; P: Portugal; UK: United Kingdom.

efficient from France, this result is due to the very important efforts made by CNRS, specially in the solid state chemistry.

Fig. 1 shows the distribution of team sizes. This is not the size of the laboratory, but the size of the teams working on lithium batteries. As it can be seen, a significant amount of scientists are working alone, or in a team of 2. Only few laboratories have large teams, over 10 people, which is not surprising for university laboratories.

The most important information comes from the people repartition by R&D subject, as described in Table 3.

As it can be seen, positive materials study is the preferred topic, far in front the others and still progressing. The reason is probably the prominence of solid state chemists in the population of scientists interested in lithium batteries. This type of study, supported by a lot of sophisticated equipment, is very favouring compared for example to the study of solvation in organic liquid electrolytes. It includes most of the time structural investigations in relation with electrochemical insertion/deinsertion, and, in less extent, material preparation. Then comes the polymer electrolyte, which is still a popular advanced subject, for many years. The relatively small work on lithium is due to the massive move towards insertion anode since 1990. Technology studies were specially mentioned for the private R&D work, however polymer technology seems to capture lot of attention, with a significant increase of interest these last years.

The number of publication is another means to quantify the activity in a particular domain. Table 4 describes the number of papers published during the last 5 years by subject. It follows fairly well the people distribution.

Table 5 represents the number of patent filed by the public laboratories during the last 5 years. It does not mean

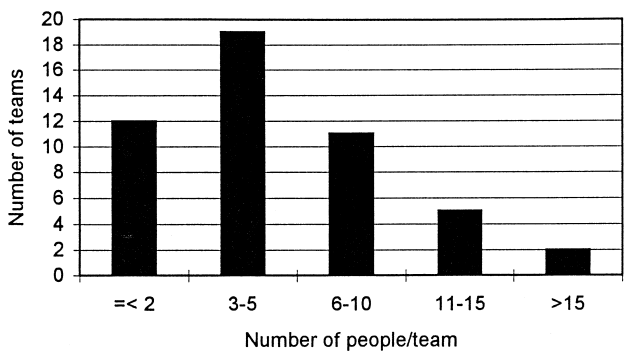

Fig. 1. Public research on Li batteries in Europe: distribution of research team size.

Table 3
People distribution by research subject

	1993		1998		Variation
Positive material	57	29%	91	33%	59%
Negative insertion material	23	12%	38	14%	69%
Lithium	14	7%	18	6%	27%
Liquid electrolyte	10	5%	17	6%	63%
Polymer electrolyte	37	19%	51	18%	38%
Technology, liquid electrolyte	7	4%	7	2%	−3%
Technology, polymer electrolyte	8	4%	15	5%	83%
Modelisation	4	2%	6	2%	54%
Fundamental electrochemistry	24	12%	24	8%	—
Solid state electrolyte batteries	9	5%	8	3%	−12%
Miscellaneous	1	1%	4	1%	
Total	195		279		43%

Table 4
Distribution of the publications by subjects for 5 years

Rechargeable Li	833	88%
Primary Li	114	12%
Positive material	274	29%
Negative insertion material	113	12%
Lithium	55	6%
Liquid electrolyte	33	3%
Polymer electrolyte	199	21%
Technology, liquid electrolyte	6	1%
Technology, polymer electrolyte	49	5%
Modelisation	19	2%
Fundamental electrochemistry	108	11%
Solid state electrolyte batteries	108	11%
Total	947	

Table 5
Patent filing by public organisation for 5 years

Positive material	23	29%
Negative insertion material	11	14%
Lithium	0	0%
Liquid electrolyte	7	9%
Polymer electrolyte	18	23%
Technology, liquid electrolyte	6	8%
Technology, polymer electrolyte	7	9%
Modelisation	0	0%
Fundamental electrochemistry	0	0%
Solid state electrolyte batteries	8	10%
Total	80	

that all these patents are still active but it gives a significant picture to show that an important part of this research is made towards application. Indeed, to the question: 'do you cooperate with private companies or organisation?', the answer was positive for more than 86%. That shows the determinant role of the battery industry to motivate this research activity.

3. Conclusion

In conclusion, the result of this survey shows that the effort made by public research laboratories on lithium batteries is quite important, and is increasing significantly. All the main research subjects are addressed, the major part of the work being devoted to solid state chemistry/electrochemistry, for both positive and negative materials. Polymer electrolyte studies are still important, but in a relative smaller expansion. Most of this work is application-oriented and made in relation with the battery industry. Such a cooperation has been continuously promoted for years by the European Commission, with important funding of this research activity. The choice of research topics is therefore strongly influenced by the funding opportunities.