U.S. Environmental Protection Agency, Washington, DC 20460, USA

References

1. R. W. Hart, D. A. Neumann, R. T. Robertson, Eds., *Dietary Restriction: Implications for the Design and Interpretation of Toxicity and Carcinogenicity Studies* (ILSI Press, Washington, DC, 1995).

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Battery Innovation and E-cars

The Policy Forum "Environmental implications of electric cars" by Lester B. Lave *et al.* (19 May, p. 993) triggered a number of critical comments (Letters, 11 Aug., p. 741) about the database and the conclusion that "a 1998 model electric car is estimated to release 60 times more lead per kilometer of use relative to a comparable car burning leaded gasoline." This conclusion was reached under the assumption that electric cars would use lead acid batteries and that the primary and secondary lead production as well as processing in the manufacturing sector were using pyrometallurgical processes and casting for grid production. All of these processes give rise to lead release to the environment, the amount of which, however, was severely overestimated by Lave *et al.* Modern manufacturing practice with drastically improved emission control was not taken into account.

Electrometallurgical processing of primary and secondary lead and galvanic manufacturing of battery grids are emerging technologies that can alleviate most of the residual lead emission resulting from modern lead processing. The California Air Resources Board (*1*) has estimated these emissions to be as low as 1/1000 of the amount derived by Lave *et al.*

Electrochemical processes to recycle the lead components—grids, top lead, and paste—of spent batteries has been described and analyzed recently by R. D. Prengaman (*2*). In essence, these processes do not release lead or lead compounds into the air. More recent process developments (*3*) have led to the reduction of the direct production cost of lead from about $0.09 per pound for pyrometallurgical processes to about $0.065 per pound. All phases of this process have been fully tested; they are operational in commercial facilities for the separation of battery components in 14 installations in different countries, four of which are in North America. The electrochemical part of this process has been successfully tested in a demonstration pilot plant of one of the main lead producers in the United States. In view of the difficulties of assessing emissions from pyrometallurgical and battery manufacturing plants by traditional means (*1*), it would be premature to try to compare emissions from electrometallurgical processing, but probably such emissions will be drastically reduced.

Moreover, a new process has been invented that permits one to produce battery grids directly from a lead electrolyte by galvanic deposition in the net shape required (*4*). This process can eliminate the casting of lead grids or strip altogether. Moreover, it permits significant weight reduction estimated to exceed 10%. A more accurate figure cannot be given yet because of the intimate interrelation between material, manufacturing process, and battery design, which is still under development. This new manufacturing route for battery grids even lends itself to being combined in one economical process with electrometallurgical recycling of spent batteries.

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References

1. *Metal Bull.* (10 July 1995), p. 11.
2. R. D. Prengaman, *J. Miner. Metal. Mater. Soc. (JOM)* 47, 1 (1995).
3. M. Olper, paper presented at the Conference on Recycling Lead and Zinc into the 21st Century, Madrid, Spain, 18 to 23 June 1995.
4. H. Warlimont and M. Olper, *J. Miner. Metal. Mater. Soc. (JOM)*, in press; German patent DE 44 04 817 C1, international patent applications pending.

Response: We will be delighted if the new production process is successful.

The paper by Prengaman cited by Warlimont and Olper is an excellent summary of the known, but not commercialized, technologies for hydrometallurgical and electrowining processing of the lead paste or battery sludge. Prengaman points out the special problems of recovering lead from a sludge composed of lead sulfate, lead dioxide, other lead oxides, metallic lead, and small fractions of other battery materials including sulfuric acid. Although Prengaman and Warlimont are optimistic about overcoming some of the problems with these processes, it remains to be seen if Prengaman's forecast that a full-scale electrowining plant will be operating in the next decade will be accomplished.

If extraordinary pollution control measures become the norm for the industry, lead air emissions would be greatly reduced, but the lead collected would still need to be managed and contained. We look forward to reading Warlimont and Olper's paper in press.

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Among the Young

It was good to learn that as a professor I can hope to retain my recall abilities as I age ("How to be a sharp senior," Random Samples, 10 Nov., p. 921). At 43, I was very pleased to see I still fall into the "young" category. But what *really* made my day was to learn that my forgetfulness is normal: The "young" control group seems to have outscored all age categories of professors. I think there was a point to this, but it slips my mind. . . .

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The figure accompanying the 10 November Random Samples item describing the study at the University of California, Berkeley, by Arthur Shimamura and colleagues evaluating the preservation of cognitive function in elderly professors supports the conclusion that "the professors showed much less cognitive decline with age than the general population."

There is no comment, however, about an additional interesting aspect of the figure: the young "controls" scored better than the young professors! Were the "controls," perhaps, Stanford professors?

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Letters to the Editor

Letters may be submitted by e-mail (at science_letters@aaas.org), fax (202-289-7562), or regular mail (*Science*, 1333 H Street, NW, Washington, DC 20005). Letters are not routinely acknowledged. Full addresses, signatures, and daytime phone numbers should be included. Letters should be brief (300 words or less) and may be edited for reasons of clarity or space. In October 1995, our previous policy of consulting with all letter authors before publication was discontinued.