The compact, modular welding equipment developed especially for series production is easy to integrate into workpiece carrier systems or rotary indexing tables

Competing Processes. The increasing use of laser welding is due in no small part to the many technical advantages it offers. With regard to the economic advantages, prejudices still exist on account of higher investment costs and the, in some circumstances, higher costs for suitable materials. Any comparison with other processes must consider all aspects.

Is Plastic Laser Welding Economical?

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The automotive supplier industry is particularly characterised by very high innovation and cost pressure. Thus, automotive suppliers are continually looking for innovative technologies that will enable them to offer their customers better quality products at lower prices. In order that these goals may be reached, all production processes need to be continually analysed and optimised.

Plastic laser welding is noted for its very readily controlled local and non-contact introduction of heat, minimal heat influence zone and low mechanical stress on the adherends. Moreover, the process is totally free of debris, unlike other welding processes. Accordingly plastic laser welding is predestined for applications in which sensitive electronics are located in parts that have to be welded, high quality welds have to be obtained or absolute cleanliness is essential in the process [1].

Despite these technical advantages, many users are still hesitant about using it. The reason for this is frequently higher capital outlay and perhaps higher costs for special materials. To illustrate this, a joint study was conducted with an automotive supplier company to compare the system efficiency [2] of bonding and laser welding using the example of an electronic housing.

The automotive part in question consists of a plastic housing and two plastic covers. The housing contains electronics fitted out with sensors and a printed circuit board. The purpose of joining the covers is to prevent the electronics from being contaminated. Up until now, the company used to bond them together but decided to try out plastic laser welding as a possible alternative.

Bonding Versus Laser Welding

In line with the system efficiency concept [2], the evaluation included not only quantitative evaluation criteria (such as investment costs, material costs) but also qualitative influences (such as the quality of the join), along with operating personnel. Table 1 compares the essential advantages and disadvantages of plastic laser welding with those of bonding at an automotive supplier company for the part under discussion.

Input. A special advantage of laser welding over bonding is that no addition- ▶

Process control through monitoring joining travel

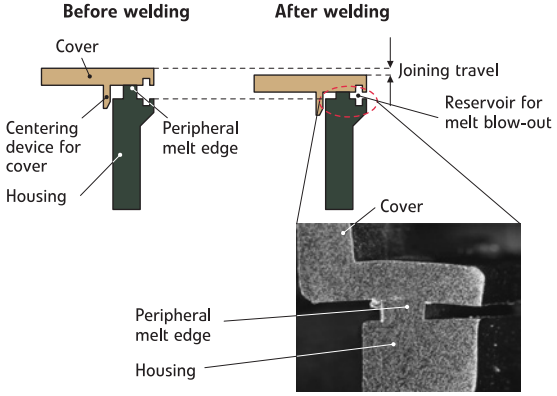

Fig. 1. Measurements of the joining distance provide information about melt flow during welding process and thus about the eventual weld [3]

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al material is needed for the joining process. This eliminates handling of the adhesive along with procurement and inventory costs. However, laser welding imposes greater demands on part geometry; adhesives are better able to compensate for unevenness in the joining area. A disadvantage is also the fact that the plastic initially used for the housing cover was not laser transparent. For this reason, a somewhat more expensive material amenable to laser processing had to be used. In contrast, laser welding, unlike bonding, does not require cleaning of the material. The laser beam can cope with minor impurities on the material's surface. The joining process also requires substantially less energy since there is no curing process involved in laser welding.

Output. The mechanical strength and long-term stability of a plastic laser weld are qualitatively superior. The reason is that the welding process does not change the chemical or physical properties of the plastic, whereas the adhesive's own behaviour (toxicity, ageing, embrittlement) constitutes an additional uncertainty factor.

In plastic laser welding, the requirement for online process control is fulfilled with joining-travel monitoring (Fig. 1). By contrast, the success of bonding can only be checked at the end, i. e. after the adhesive has been applied, has cured and the exhaust gas outlet has been sealed. With bonding, it is not possible to reduce the risk of rejects by quickly intervening in the process.

Technology. Laser welding offers much greater development potential than bonding since the process is amenable to further optimisation. As regards flexibility, no special changes are discernible; product changes require the same amount of effort in both processes. However, laser welding can be automated to a higher degree because there is no need to manually change an adhesive container.

Organisation. The throughput time for the electronic housing is much shorter in the case of laser welding because there is no cleaning, no time-intensive curing, and sealing of the exhaust gas outlet is eliminated (Fig. 2).

There are also much fewer process stages in laser welding as there are fewer activities involved (cleaning, sealing the exhaust gas outlet, replenishing the adhesive). The space required for the bonding process is a multiple of that needed for laser welding. For example, laser welding does not require any cleaning or curing equipment or any storage areas for adhesive.

Personnel. The number of staff required in both cases is the same. However, because fewer activities are involved in laser welding, the operators can take on other duties. As far as necessary qualifications are concerned, among the operators involved in laser welding only one needs to be trained as laser protection officer. There is no difference in the amount of time needed to learn how to use the machines.

Costs. A comparison of unit costs revealed that plastic laser welding is roughly 70 % cheaper than bonding. This clear cost advantage is possible despite the somewhat higher cost of acquiring the appropriate material mainly because the costs of adhesive and housing cleaning are eliminated and because laser welding takes up much less processing time. It was also found that the investment costs amortise extremely quickly because of the clear unit cost advantage.

Revenues. Plastic laser welding yields markedly improved revenues not least because of the improved unit cost position but also because of knock-on effects in other areas. Even if these gains in innovation have to be passed onto the automotive producer, at least a competitor will be prevented from being awarded the contract on account of lower prices.

Conclusion

As may be clearly seen in Table 1, both the technical and economic aspects impressively illustrate the advantages of laser welding over bonding. This process com-

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Automotive supplier company			
Evaluation criteria and features		Evaluation comparison	Explanations
Evaluation criteria	Evaluation features	Compared with bonding, laser welding is: Much worse / Worse / Slightly worse / Same / Slightly better / Better / Much better	Brief comments on joining method: laser welding (L) compared with bonding (B)
Input	Nature and quantity of additives		Unlike adhesives, L requires no additives.
	Demands on part geometry		Higher for L, since part unevenness is easier compensated in B.
	Nature of housing material		Material amenable to laser is needed for L. This is somewhat more expansive.
	Material cleaning		Not necessary for L prior to joining.
	Energy input for joining		Much lower for L. No curing is needed.
Output	Quality of join		L is better (e.g. as regards mechanical strength).
	Reject		Less rejects with L because of the processing monitoring.
	Scope for quality control		Unlike B, online quality control is possible for L.
Technology	Development potential of the joining methods		Unlike B, L is an innovative technology.
	Flexibility		No major differences noticeable.
	Degree of automation		No need to feed joining material in case of L.
Organisation	Throughput time		Much better for L, since inter alia no curing needed.
	Number of activities		Much better for L, since no finishing activities needed.
	Space requirements		Much better for L, since no cleaning or curing equipment needed.
Personnel	Number of personnel needed		Personnel requirements same for both processes.
	Qualifications needed		L requires a laser protection officer. No change otherwise.
	Learning times		Learning times for L no greater than for B.
Costs	Unit costs		L incures much fewer costs due to nature of process.
Revenues	Revenues per part		L increases revenues due to its advantageousness.

Table 1. Laser welding compared with bonding based on the example of a plastic part for the automotive industry

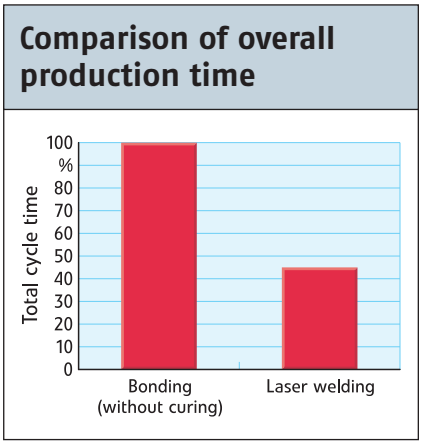

Fig. 2. Cleaning, curing and sealing the exhaust gas outlet are eliminated in plastic laser welding

parison has also shown that the technical-economic advantages of a joining process cannot be determined solely on the basis of capital costs or material costs. Following the analysis, the automotive supplier company concerned substituted laser welding for the bonding process. No generalisations can be made as to whether plastic laser welding is always the most favourable alternative, and all advantages and disadvantages need to be weighed up in each individual case. ■

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