# MATERIALS NEWS

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## EDITORIAL

This issue of Materials News is devoted to one topic — Powdered Metal Parts. We thought we would try something different this time in treating one of TEK's "floating" topics.

By "floating" we mean one of those general topics that crop up in various areas here at TEK. These topics appear to be useful in our processes. Several people may have ideas or have done development work on them. But these efforts seem non-coordinated and therefore real progress is hampered to some degree.

It is our aim in this issue to pull together the various threads of know-how that already exist regarding this subject and try to weave them into a fabric that would give an overall view of the topic. If you can add a 'thread' please let us know. We will be glad to publish further articles on the subject.

-Tom Currans, Ext 362
Hybrid Components Eng

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## POWDER PARTS PRODUCTION

Production of parts by powder-metallurgy methods has been viewed by both Ceramics and Metals & Plastics for a number of years as a logical possibility, provided the demand for such parts warrant it.

With the reduced use of strips in new instruments a major part of Ceramic's pressing capability could be used for small metal parts

Ceramics shares with Metals & Plastics a wealth of experience in "pressed part" design and carbide die technology stemming from years of part production. In addition, Ceramics is well versed in powder preparation techniques and binder selection necessary for optimum pressing conditions. We have pressed and sintered some Hoeganaes iron powder and find no difficulty in achieving general property values equal to or better than those reported by the manufacturers. Special problems such as low density and plating difficulties in critical parts areas would require extra attention.

We now purchase at least five PM parts such as knob inserts and small gears. At least six more parts will be used in new instruments.

Undoubtedly, more potential uses now exist within TEK, and will be realized as parts designers become more familiar with the PM system. Used with intelligence, the PM technique should contribute positively to TEK's future "parts production" capabilities.

-Jerry Turnbaugh, Ext 6330
Ceramics Engineering

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## PLATING POWDER METAL PARTS

Tektronix is now plating five powder metal parts. The armatures and cores in the relays for the 576 and other new instruments are made from powdered silicon iron (99.9% Fe). The parts are annealed, vacuum sealed, and plated with .000200" to .000450" of electroless nickel. The two parts in the 491 crank handle are made of nickel-silver, vacuum sealed and then plated with copper-nickel-chrome. The holder connector on the S-5 is also nickel-silver, and plated with copper-albaloy. The nut block for the New Generation plug-ins will be made of nickel-silver and plated with .0003" min. of bright nickel.

The cost and reliability of powder metal depends on the part design and the manufacturer's ability to build adequate tooling. Before a part design is finialized, it would be beneficial to consult prospective manufacturers. This could save a lot in tooling expense.

The main problem that is encountered in plating powder-metal is the porosity of the parts caused by poor design for pressing, or inadequate techniques used to make the part. The parts are plated to improve their electrical or magnetic properties. If the parts are porous to begin with the electrolytic solution becomes entrapped in the parts and causes (1) salt formation on the surface, and (2) accelerates the corrosion on the inside of the part reducing its strength. To prevent this we reduce the porosity of the parts by vacuum sealing. In some cases we have taken parts that were unusable (poor corrosion resistance) and made them usable by this method. This of course is more expensive.

Powder-metal parts definitely will have many useful applications at Tektronix. The success of powder-metal will depend on how well we design for processing.

-Dennis Kuhnle, Ext 7802
Electrochemical Eng.

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## JOINING OF P/M

Generally speaking, sintered metal parts may be joined to similar or dissimilar materials by conventional joining techniques--welding, soldering, or brazing. As with conventional metals, alloy composition will dictate the preferred type of joining technique. The closer the quality or density approaches that of the wrought material the better the integrity of the joint. Each application must be designed for the specific powder metal alloy and the intended joining technique.

-Basil Gilman, Ext. 7133
Materials Application

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## POWDER METALLURGY

Powder metallurgy may be generally defined as the art/science of fabricating solid metal geometries from a pure metal or metal alloy powder. It is one of the oldest of all metalworking processes.

Iron and copper base alloys constitute the majority of structural powder metallurgy parts, however, it is significant to note that most tungsten, molybdenum and beryllium parts are fabricated by powder metallurgy.

### Advantages

The powder metallurgy process is unique as a manufacturing tool. In many instances the process offers manufacturing possibilities, otherwise unobtainable by other methods, such as the following:

1. Making a strong piece of metal from powder without fusion.

2. Molding parts to definite shape and heat-treating to retain shape without using the mold during the heating cycle.

3. Machining may be reduced or eliminated which results in lower materials and labor costs.

4. Cementing high-melting metal powders (e.g. tungsten) together by fusing with lower melting metals.

5. Mixing metals which do not ordinarily alloy with each other. With powder metallurgy there is no limit to the range of mixtures or alloys of metals with other metals or nonmetals. This technique can produce a uniform composite structure with "tailored" physical properties (sintered carbides and tungsten-silver electrical contacts are examples).

6. Making structures with controlled porosity ranging from no porosity to 50 or 60% porosity.

### Design Considerations

Some primary limitations to processing powder metallurgy parts, should be considered. The shape must permit extraction from the die and holes and undercuts not parallel to die travel axis must be made by secondary operations. Also, dies are expensive so a minimum run of a few thousand parts are required for a reasonable part cost.

Extreme dimensional and physical requirements also increase the cost of the part. For moderate physical properties of a specific alloy with a sintered density of about 80% of theortical, the nominal tolerance is about ±.002 in/in.

At present, only moderate utilization of powder metallurgy is employed at TEK for parts such as small gears. The possible advantages of powder metallurgy are such that more consideration should be given to the process for producing small components when moderate to high usage is anticipated. As with other processes, such as casting and plastic molding, the possiblity of using a powder metallurgy part should be evaluated in the design stage before unnecessary restrictions and requirements are placed on the finished parts.

### Uses

Uses of the PM process are many. In some applications, because of economy, fabrication difficulties and special desired properties, it is "the only way to fly." Some examples are:

- Combined copper and steel self-brazing alloy
- Self-lubricating (oilite) bearings
- Combined silver (or copper) and tungsten for electrical contacts
- Hard carbide-metal mixtures for cutting tools
- Manufacture of alnico permanent magnets

### Process

Three fundamental steps are involved in the process of pressing and sintering metal powders which have not altered much since the time of the Incas.

1. Weighing and mixing of powders, lubricants and binders. The lubricant aids compactions while the binder, usually a lower melting constituent serves to bond the higher melting constituents together during sintering.

2. Cold pressing of the mixture under very high pressures in a die to form the part into a "green" briquette of approximate shape and size desired. During cold pressing with pressures up to 60 tons per square inch, air is expelled from the powder mixture and the initial bond between the metal powder particles is established which provides sufficient strength for handling.

3. Sintering or heating the briquette in a reducing atmosphere reduces oxide films and, thus, promote complete bonding of particles.

For some parts, subsequent treatments may be required. Such as: (1) Repressing to higher densities and closer dimensions (sizing or coining), (2) Heat-treaments, (3) Rolling, forging, machining, or drawing for special shapes, (4) Oil impregnation for lubricating purposes, (5) Special finishing (buffing, polishing, plating).

-Earl Helderman, Ext 7133
Materials Application

-Kwaku Mensah, Ext 7833
Electromchemical Products

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## LITERATURE REFERENCE

Alcoa Research Laboratories report the following typical results of their latest work on aluminum.

| Alloy | Compaction | Density | Ten Str | Hardness |
|---|---|---|---|---|
| 601AB | 50,000 psi | 95% T D | 18,000 psi | 65/70 $R_h$ |
| 201AB | 50,000 psi | 95% T D | 30,000 psi | 70/75 $R_e$ |

Subsequent repressing and heat treating can increase strength by 50%.

"The Production of Precision Aluminum P/M Parts," J.H. Dudas and W.A. Dean, Int'l. Jour. Powder Met. 5 (2) 1969.

-Jerry Turnbaugh, Ext 6330
Ceramics Engineering

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