cautions pore free deposits, up to several hundred microns in thickness, may be produced. Principal applications are chemical and wear resistant coatings, reclamation, and thick film electronic circuitry.

Three other high temperature coating processes discussed were vacuum coating, diffusion coatings and pyrolytic coatings. Dr L. Holland (Edwards High Vacuum Ltd) described the principal vacuum coating techniques with particular reference to R. F. Sputtering which has proved to be a most versatile method. He outlined the range of materials which can be processed and the quality of the deposits which can be produced. Pyrolytic coatings of refractory metals may be deposited by chemical or thermal breakdown of their volatile halides, and carbon and silicon carbide from hydrocarbon and silane gases respectively. Dr E. H. Voice (OECD Dragon Project) described the Dragon nuclear fuel pellet as an example of the use of the technique. The pellet consists of a sphere of uranium oxide or carbide coated with two layers of pyrocarbon interspersed with one of silicon carbide; the total diameter is about 1 mm. The coatings are applied by a fluidized bed technique. Dr N. A. Lockington (Chrome Alloying Co. Ltd) devoted most of his talk to the chromizing process, in which a chromium rich layer is diffused into the surface of the ferrous material or nickel alloy. The most advantageous method is to use a pack process; the components are packed in an inert medium (alumina) containing ferrochrome and a halide. On heating, the halide acts as a transport medium to move chromium from the ferrochrome to the component. Several other processes operating on the same principle are feasible but apart from siliconizing, which is used to produce disilicide coatings on superalloys, they are not important commercially.

Non-metallic coatings discussed included paints and plastic coatings on metals. Dr L. H. O'Neill (Paint and Varnish Manufacturers Research Association) described several new developments in paint finishes, including thermosetting acrylic finishes which should prove to be more durable than thermoplastic acrylic lacquers now widely used as car finishes. Domestic paints containing both urethane and silicones which combined fast drying and non-drip qualities with good durability are also being developed. Dr O'Neill also discussed an intriguing development which aims to replace a conventional white pigment by a suspension of bubbles to produce an opaque finish, but these finishes have so far proved to be too soft for commercial use. Plastic coatings may be applied to metals by dipping the preheated metal part into either a fluidized bed of polymer powder or into a liquid plastisol. The former process is applicable to polyethylene, nylon and unplasticized PVC, whereas the latter is applicable only to plasticized PVC compounds. Dr G. E. Barrett (Plastic Coatings Ltd) described the precautions necessary to obtain good adhesion and satisfactory coatings. He also discussed the requirements of the polymer to render it suitable for the process. These requirements are very severe and virtually limit the fluidized bed process to low density polyethylene and nylons 11 and 12, which have the necessary wide melting range and easy flow properties without degradation.

Dr A. Rantell (Polytechnic of the South Bank) spoke on metal plated coatings on plastics. These coatings are produced by a conventional electroplating technique preceded by etching and chemical deposition stages. The essential pretreatment is the deposition of a minute quantity of palladium on to the plastics surface. This acts as a catalyst for an electroless nickel plating process which in turn provides a substrate for the conventional electroplate. Adhesion is controlled by an initial etching process. Experience has shown the most suitable substrate material to be ABS, the rubber phase of which may be etched out to provide an excellent mechanical key for the plate. More recently, techniques have been developed for plating polypropylene and nylon with satisfactory results, the basic problem being to provide a suitable surface at the initial etching stage.

Dr D. White (Houldsworth School of Applied Sciences, University of Leeds) described coatings formed by dipping metal articles into suspensions of clay minerals. Thin coatings of montmorillonite have been found to give excellent protection against oxidation on steels, and titanium alloys. This is sufficient to allow them to be heat treated at temperatures up to 750° C without other forms of protection. The exact mechanism of protection is not clear but it is known that very thin films (about 1 μm) are effective. These coatings are very cheap and easy to apply.

At the meeting the A. A. Griffith silver medal for 1971 was presented to Professor J. White (University of Sheffield) and the Materials Science Club Prize was presented to Mr S. Turner (ICI Ltd, Plastics Division).

Evolutionary Behaviour of Quasars

In attempting to fit the observational data of quasars at radio and optical wavelengths to a reasonable cosmological model, it is necessary to assume some form of evolutionary behaviour of the sources. Different workers have, however, disagreed about the precise nature of this evolution. For instance, Schmidt has claimed that only the population density of quasars is time dependent whereas the luminosities are constant, and Rowan-Robinson maintains that either density or luminosity evolution is present, but in both optical and radio properties. On the other hand, Arakelian has claimed not only that density evolution is absent, but that the optical and radio properties evolve differently.

The different conclusions of these workers are a consequence of their different ways of analysing the data (chiefly from the 3C catalogue). Rowan-Robinson has used the luminosity-volume test in which the numbers of sources in a given range of radio or optical luminosity are counted for different redshifts. Schmidt's procedure was to calculate the average value of a ratio of volumes, one corresponding to the redshift of a particular source, the other corresponding to the redshift at which such a source would disappear at the survey limit. A uniform distribution will give a value 0.5. The new feature introduced by Arakelian was to treat the optical and radio data separately. Using Schmidt's data and method as well as the 4C catalogue he found only radio (but not optical) luminosity evolution.

Arakelian's results have been subject to some doubt, and a reconciliation of the conflicting conclusions is presented in an article in next Monday's *Nature Physical Science* by L. M. Golden of the University of California. Golden points out that Arakelian's work suffers from a selection effect. Thus for a representative radio (optical) sample, those of low optical (radio) luminosity will be observed only at small redshifts. Arakelian has apparently also used a non-representative sample, and so Golden has repeated Arakelian's analysis, correcting for these effects. For this Golden essentially uses only the bright sources, and assumes an Einstein–de Sitter cosmology (although the conclusion is insensitive to the value of the deceleration parameter). The result is that the radio/optical luminosity ratio is independent of redshift for a least squares fit, indicating similar evolution at both wavelengths.

Using this result, Golden also points out that Schmidt's analysis in fact permits both luminosity and density evolution. In this way the results of all three procedures can be reconciled.