Abstract— With the invention of the transistors in the early half of the nineteenth century, the field of electronics has undergone innumerable changes that have had tremendous impact on the life of the common man. Be it education, entertainment or healthcare, there is possibly no field where electronics has not made an impact. The entire concept of electronics is based on the study of materials called semiconductors. Silicon is one such material that is widely used in the manufacture of electronic circuits. However the use of silicon has various disadvantages that have led researchers and scientists all over the world to look for other alternatives. Research has already begun for materials that can successfully replace Silicon and come out with better performances. For long, it was believed plastics were materials with poor conductivity. However researchers have proved that when plastics are combined with other substances in proper chemical compositions they can behave as good conductors of electricity. This has led to the emergence of an all-new field in which plastics or ‘conjugated polymers’ are exclusively used in the manufacture of electronic products. This is the field of POLYTRONICS. The use of plastics not only reduces the cost involved in the manufacture of electronic items, but also makes them more flexible and portable. Also Polytronics seems to be the best answer to the growing menace of electronic wastes.

Through this paper we essentially aim in presenting some of the recent development in the field of Polytronics. The paper starts with the introduction in which detailed some of the major disadvantages of Silicon that led to the emergence of Polytronics. We have also presented some of the recent breakthroughs in this field such as Printing of circuits, Rubber electronics, Electronic paper, Organic LED’s etc... (4) With deforestation, due to rampart use of organic paper, becoming a major issue of concern, Electronic paper, which is a direct application of Polytronics, is being considered as one of the best solutions. Use of Silicon in the manufacture of electronic products makes it very difficult for them to be recycled at the end of their life. Due to rapid development of electronics, more and more electronic items are becoming obsolete and their inefficient disposal has resulted in excessive damage to the environment in the form of e-waste. In this paper we have presented our views on how Polytronics can effectively reduce this problem. The paper ends with the conclusion in which we have given our views as to why Polytronics needs immediate attention.

I. INTRODUCTION

The modern day electronics industry has been largely influenced by silicon.

The very fact that silicon is widely available makes it an integral part of semiconductor chips. However the widespread use of silicon in electronic goods has a large number of disadvantages some of which are listed below:

1) Production of silicon embedded circuits involves a huge investment (to the tune of billions of dollars).
2) These circuits also consume more power.
3) Moreover since silicon chips are not flexible, the products, which make use of these, are not easily portable.

So, many organizations and institutes are on the look out for alternatives, which can effectively replace the uses of silicon and thus eliminate the above disadvantages.

This paper looks into one such alternative, an all new exciting and emerging field called polytronics.

This field essentially deals with the use of plastics or conjugated polymers as electricity conducting materials. Hence the name ‘Polymer electronics or Polytronics’.

Through this paper we have established our views on how polytronics could help in reducing the problems associated with the present day electronics.

Also in this paper we have discussed about the additional benefits that this technology can provide.

II. NEW TRENDS IN POLYTRONICS

In this section we look into some of the areas in which polytronics is making a huge impact.

2.1 Printing of circuits

Fabrication of micro electronic components would allow manufacture of complete gadgets through just printing process in the near future. Such a technology is being developed by the University of California. The technology would focus on building any electronic device from bottom up gradually, so, instead of building a device by adding new components through the regular “assemble and build” technique, the entire product would come out of the printer complete with electronic circuitry embedded in the product itself. is document as a template and simply type your text into it.
The structural, mechanical and electronic elements would be indicated using 3D printing techniques, in three simple steps: using a CAD software tool think of a design, take the necessary ingredients and insert them inside the printer and finally print. Technologists point out that for the process to succeed in major applications two main criteria have to be fulfilled: “Basically, the material viscosity must be low enough to allow controlled ejection from the inkjet during fabrication. Secondly, the material must remain a liquid for a sufficient time before jetting so as to not clog the printing orifice, yet solidify within a reasonable time after jetting”. (3)

With these two things in place it would be possible to print almost anything from a combination of polymer and oligomer solutions, polymer resins, molten solders and nano-particle suspensions. (2)

2.2 Rubber electronics

Researchers at the ‘John Hopkins University’ have successfully built rubber circuits out of several squashed but extendable gold wires. The circuits are about 20 times thinner than a human hair and have the potential to be stretched by over half their initial length without loss of electrical conductivity. (3) Stretched gold wires are manufactured by electroplating gold onto a sheet of silver, later on the silver is stripped and the wires are encased inside the polymer. The rubbery circuits would be woven into clothes to monitor the heartbeat of sports persons or for better functions such as artificial nerves that can bend inside the body. (1) Such flexible circuits would be less painful to embed in the brains of persons suffering from Parkinson’s disease. (1)

3.1 Electronic paper

The paper and pulp industry which produces huge amounts of inorganic pollutants such as sulphides, bleaching liquors and organic pollutants like cellulose fibers, bark, wood, sugars, organic acids etc which leads to various forms of pollution. (4) The axing of trees for the purpose of use in such industry leads to deforestation, which in turn leads soil erosion and other, related problems. (3)

One way to overcome this problem of resource consumption and pollution due to extensive use of paper is to have a single sheet that can be updated regularly. This is precisely what e-paper is all about. (3)

An E-paper can be continuously updated via the Internet and even used as an innovative display that can be rolled up tightly without any damage. These display devices are produced using direct inkjet printing technology as it is quite economical and the circuit is a part of the whole display package itself. The display typically uses E-ink, which is activated by electric charge to update the content. (3)

Researchers at Philips semi-conductors are working on a prototype whose circuitry is made from a semi-conducting organic material called ‘pentacene’. (2) They laid thin films of pentacene on a flexible plastic by simply spreading a solution of the organic material over the plastic substrate. Since the circuit is a part of the display itself, it is economical to produce. Research is also in progress to create full colour display, which would be four times brighter than the devices made from liquid crystals. (3)

A prototype is being developed in which the researchers have made use of a single sheet covered with electronic ink that looks like ordinary paper. (1) The information is stored in a portable chip, and a slim line lightweight battery powers the display. The ink would rearrange electronically fast enough to show even video movies. (4)
3.2 Plastic batteries

Batteries are indispensable sources of power in our day-to-day life. However with their widespread use and the ineffective ways in which they are disposed has led to serious environmental problems.

To tackle this problem, researchers have developed all plastic batteries in which both of the electrodes and the electrolytes are made of polymers. The positive and negative electrodes are made of thin, foil-like plastic sheets. Electrolyte is a polymer gel film placed between the electrodes holding the battery together.

These batteries are lightweight and can be moulded into any size and shape for use in satellites and important military equipment. Scientists are planning practical applications of plastic batteries by linking them with solar cell charging system to power space satellites when they are in orbit.(4)

Tests at the Hopkin’s lab have yielded positive results. Polymer batteries can be recharged and reused a number of times without loss of power.(2) Besides these don’t contain hazardous chemicals typically found in nickel-cadmium cells and are therefore environmentally safe.(3)

IV. INNOVATIVE DISPLAY OPTIONS

We expect our displays to produce crystal clear images, but what if they could be erased and updated for use over and over again and most importantly rolled up to fit in your pockets? It may seem impossible, but such are the possibilities that polytronics can offer.(4)

These type of display units basically make use of OLED’s or organic light emitting diodes. These can be made on almost any flexible or stiff substrate. Basically they are emissive displays, ie, they create light and don’t need a separate backlight to provide light for the image. This technology can be used in new generation of digital cameras, mobile phones and PDA’s. Even clothes with moving pictures are possible.(1)

Moreover these display units have other inherent advantages as well:

Firstly they are thin, light weight and also allow wider viewing angle. Secondly they can be read in bright sunlight unlike the present display units. Thirdly and most importantly they help in reducing environmental pollution caused due to electronic wastes.(2)

4.1 Electronic wastes

Any waste that has a circuit board or CRT is called an E-waste. Environmentalists and officials say the waste contains more than 1000 different toxic substances harmful to human beings and the environment.(3)

“If we do not wake up now, in the next five years it will boomerang on us,” said Bakul Rao, a consultant with the Environment Management and Policy Research Institute, a research body set up by Karnataka state's Pollution Control Board.

As IT firms continue to swamp India's technology hub of Bangalore, the city is starting to choke under a heap of e-waste generated from obsolete computers and discarded electronic components.(2)

![Image](image-url)

The Environment Management and Policy Research Institute says that next year about 1000 tonnes of plastics, the same equivalent of iron, 300 tonnes of lead, 0.23 tonnes of mercury and 43 tonnes of nickel and 350 tonnes of copper will be generated as e-waste in Bangalore.(1)

"This figure will increase by ten-fold in 2020 when Bangalore will generate one-third of the state's e-waste," Rao said. "The findings are quite alarming as there are no regulations and no scientific disposal systems."

Bangalore has more than 500 recyclers of discarded computers and electronic components. They sell second-hand parts either to computer assemblers in the grey market or to buyers directly at the weekly Sunday bazaar.

"There is no scientific recycling happening anywhere in Bangalore. Most of the e-waste including lead and plastic is dumped along with the municipal waste and then burned," Rao said.(1)

"Bangalore has more than 100 illegal dump pits for e-waste," she said.

The burning of printed circuit boards at a low temperature leads to the release of extremely toxic components which can cause cancer, a report by the institute said.(4)

Barium found in e-waste, it added, could damage the heart and liver while other chemicals such as beryllium found in computer motherboards and cadmium in chip resistors and semiconductors are poisonous and could lead to cancer.
Chromium in floppy disks, lead in batteries and computer monitors, and mercury in alkaline batteries and fluorescent lamps also pose severe health risks. Other substances such as copper, silver and tin could also be damaging, the report said. 

Therefore there is an urgent need to do something about this problem and Polytronics could well be the solution for the same. 

4.2 Plastic recycling 

Since it has been noticed that plastic is also being considered as an important part of electronic waste, effective recycling of plastic is the main issue, which limits the use of Polytronics in mainstream electronics. The American plastics council has been announcing the safe recovery of plastic from electronic equipments 

MBA Polymers, Richmond, CA, includes an "advanced plastics recycling line" that is developing and demonstrating new technologies for durables recycling. These include technology for plastics identification and sorting, and improving the quality and reducing the costs of recovering plastics from durable goods. Currently, APC (American plastics council) and others are conducting research to evaluate recovery of telephones, automotive parts, computer housings, refrigerator doors and cabinet liners. 

Through such organizations, the plastics industry is developing technologies to collect, sort and reclaim plastics more economically, broadening its focus to include durable products and commercial streams, researching new applications and end-markets for recycled plastics, and promoting existing markets through publications such as "The Recycled Plastic Products Source Book" and "Shop Recycled!" The American Plastics Council offers the following services and resources: 

**Toll-Free Information Line** -- Community officials and recyclers can get the technical information they need by calling 1-800-2-HELP-90. Information Specialists can access APC's databases listing more than 1,700 plastics handlers and reclaimers to match supply with demand for post-consumer plastics. 

**Technical Research Programs** -- The state of the art in plastics recycling is constantly evolving. APC works to hasten this evolution, pursuing a wide range of technical solutions that can add greater automation and operating efficiency to each step of the plastics recycling infrastructure, from collection to end-markets. 

The findings from these research programs have resulted in a series of technical manuals to help advance plastics recycling across the country. 

Moreover since the display units that polytronics offers is completely made of different types of conjugated polymers, only plastics recycling has to be addressed unlike in the case of present day display units wherein you have a whole range of toxic and hazardous substances to consider. 

V. CONCLUSION 

In this paper we have explained in detail some of the recent breakthroughs in the field of polytronics. When implemented properly, polytronics can bring about a revolution in the life of common man. 

We would like to conclude the paper by highlighting the importance of polytronics. 

Infact the question to be answered at this stage is “Why Polytronics?” Apart from the exciting features that we have discussed so far such as printing of circuits, electronic paper, OLED’s, rubber electronics etc… Polytronics has a major role to play in protecting our environment. With efficient use and reuse of such products we can go a step ahead in the issue of electronic waste. Apart from safe guarding the environment in which we live, use of plastics in the manufacture of electronic products bring down the cost involved in production, thereby safeguarding the interest of the economy as well. The aim of Polytronics is to build products that can reach the substratum of the society, to build a better society in which each and every individual has access to the features that it has to offer. 

Through this paper we would again like to emphasize the fact that Polytronics is the next BIG THING. 

In short it is a field that offers tremendous opportunities for young and budding engineers, field that is going to revolutionize the way in which we live. 

REFERENCES 

[1] Electronics for you 