**////Title: Repurposing Plastic COVID Facemasks to Improve the Steel-Making Process**

**////Standfirst:**

Since the beginning of the COVID-19 pandemic, billions of plastic facemasks have been used and disposed of, with the majority destined for landfill. Professor Andrew R. Barron and his team at the Energy Safety Research Institute in Swansea, Wales, have developed an innovative method for repurposing these used facemasks. By transforming them into a powdered material that acts as a reducing agent, Professor Barron’s team aim to make the steel-making process more energy-efficient and sustainable.

**////Main text:**

During the global COVID-19 pandemic, the World Health Organisation and governments across the globe recommended or mandated the use of face coverings in public settings to suppress viral transmission. Although many governments specified that reusable fabric face coverings were suitable, medical-grade plastic facemasks were also widely adopted by members of the public.

In recent years, single-use plastics are being phased out by many countries and corporations, in an effort to reduce the amount of plastic waste that goes to landfill or ends up in the ocean. Shockingly, during the height of the pandemic, UK residents were using 102 million disposable plastic masks every week. This amounted to an additional 300 tonnes of plastic waste generated each week in the UK alone.

These mass-produced blue facemasks contain a mixture of different plastics and a metal wire. For these reasons, they are difficult to recycle at present.

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In the steel-making process, large amounts of by-product dusts are produced. These by-products contain valuable metals such as zinc and iron, which can be recovered by a reduction reaction in a so-called rotary **hearth** furnace. In this reaction, a carbon source such as coal dust is used as the reducing agent. However, global efforts to reduce our reliance on fossil fuels and to minimise plastic waste has meant that mixtures containing both coal dust and milled plastic waste are being investigated as an alternative.

However, there are challenges with this approach. For instance, it is difficult to store and transport milled plastics, as they can pose an airborne health hazard, and their low density means that they take up a lot of space. It is also important that the plastic particles are milled to within a specific size range to allow for briquetting to take place. This is extremely challenging with plastic fabrics, such as those in facemasks, due to the fabric’s ductility. A further difficulty with facemasks is that most of them contain a metal nose wire, which needs to be removed before milling.

In order to overcome the challenges associated with using plastic facemasks in steelmaking, Professor Barron and his team developed an innovative new process that ultimately produces a material with superior reactivity when compared to coal dust alone. The enhanced reactivity of this material means that valuable metals can be recovered from the by-products of steelmaking in a shorter amount of time or at a lower temperature. A lower temperature or less time in the furnace means that less energy is used, making the recovery process far more sustainable.

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In order to produce these materials with superior reactivity, the team first chopped the facemasks into small pieces. The metal nose wire in these masks did not need to be removed beforehand, which also makes the team’s process more realistically scalable than previous methods.

The researchers then added the pieces of facemask to a batch of coal dust waste and heated them, which softened the plastic and enabled better mixing. After cooling the mixture, the metal material from the nose wire could be simply removed using a magnet. The final powder was more granular than typical fine plastic powders, making it is less hazardous and also easier to store and transport.

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To investigate the microscopic structure of the powders they had produced, the team used a scanning electron microscope. Through this powerful technique, they discovered a change in the surface texture of the coal after adding and reacting with the plastic facemasks. They also estimated the surface area of the samples and confirmed that the addition of the facemask plastic had created a more porous material with a much higher surface area. A higher surface area means that there is more surface for the reduction reaction to take place on, leading to increased reactivity.

Using a technique called thermal gravimetric analysis, Professor Barron and his team specifically measured the reactivity of their new powdered material. This technique heats a material to very high temperatures and measures the amount of mass lost due to physical and chemical changes that occur as the material heats up.

One important reaction that occurs in the recovery of metals after the steel-making process is gasification with carbon dioxide. By carrying out thermal gravimetric analysis under a carbon dioxide flow, the team was able to mimic the conditions of a rotary **hearth** furnace and better understand the reactivity of their powder.

Professor Barron and his colleagues found that their new material increased the rate of the reaction with carbon dioxide, with full conversion of the material at 993 degrees Celsius compared to 1155 degrees Celsius for coal dust alone. On an industrial scale, this would mean that lower temperatures could be used in the furnace, saving energy and reducing operating costs.

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Although the work by Professor Barron and his team largely focussed on metal recovery in a rotary **hearth** furnace, their material would also be suitable as an alternative carbon source in blast furnaces, where iron is produced, and electric arc furnaces, which are used for recycling scrap steel and a key technology for decarbonising the industry.

Finding new and innovative ways to repurpose single-use plastics such as facemasks is an extremely important area of research, in order to drastically reduce the amount of plastic going to landfill and ending up in the environment. By utilising plastic waste as an alternative carbon source to coal, Professor Barron’s method also helps to reduce our reliance on dwindling fossil fuel reserves. Finally, by producing a superior material to coal dust, the team’s innovative approach helps to reduce the energy demands of steelmaking, further boosting the sustainability of this essential process.

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This SciPod is a summary of the paper ‘Facemasks and ferrous metallurgy: improving gasification reactivity of low-volatile coals using waste COVID-19 facemasks for ironmaking application’, in *Scientific Reports*. [doi.org/10.1038/s41598-022-06691-w](https://doi.org/10.1038/s41598-022-06691-w)

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